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ROBERT ANDREWS MILLIKAN

EDITOR'S OUTLOOK

THE presence in this issue of the JOURNAL (pp. 1061–73) of the dedicatory address for the opening of the new science building at Millsaps College offers the psychological occasion to preface the May number with the genial and forceful countenance of the author of that address, one of America's most distinguished physicists, Robert Andrews Millikan. Reading between the lines of his apologia for science, it is not difficult to take the tempo of Dr. Millikan's career, which, in setting a new measure in the intellectual field in which it centered, has never lost count of the rhythmic pulse of human values breaking across its own movement.

Robert Andrews Millikan
1868–

Dr. Millikan's ancestry is a New England blend of Scotch and English, and his upbringing was in the Middle West, where indeed the greater part of his life has been spent. He was born in Morrison, Illinois, the son of a Congregational minister, and his youth was passed in Maquoketa, Iowa. In 1886, he entered Oberlin College, at which both his parents had been educated and in 1891 received the B.A. degree upon the basis of a course whose liberal tendencies, viewed in the light of his after successes in science, is an eloquent argument against a narrow vocational training. His intenser scholastic interests were Greek and mathematics. He was not a bookworm. The youth was father to the man, and the natural interests of this period of his life had their rightful place in it. His success in athletics and his responsibilities in student activities, which failed to impair the quality of his scholarship, attest the strength of his popularity with colleagues and professors alike.

One semester of training in physics was the slender preparation with which in 1891 Millikan began teaching at Oberlin the science whose limits were to be so widely extended by his life-work, and it was in the course of teaching it that his interest in the subject was awakened. Columbia, Berlin, and Göttingen gave him his specialized training, and in 1896, with a Ph.D. in physics from the American university and with a broadened outlook from his German residence, he assumed the post of assistant in physics at the University of Chicago. Here through a quarter of a century he remained, climbing the professional ladder steadily but gradually, and pursuing the researches which brought him fame.

The most significant of these investigations have been the establishment of the atomic structure of electricity through the isolation and measurement of the electron; the direct photoelectric evaluation of the fundamental radiation constant known as Planck's h, his researches on which initiated a train of studies which finally gave experimental verification to the Einstein law of the photoelectric effect; the study of Brownian movements in gases, resulting in the defeat of the opposition to the atomic and kinetic theory of matter; the extension of the known ultra-violet

spectrum; the discovery of the "law of motion of a particle falling toward the earth after it enters the earth's atmosphere"; the development of the fundamental concept of the "spinning electron" through the new spectroscopic laws based on studies of the properties of light atoms; studies on the nature of metallic conduction; and the later and current investigations of the nature and properties of cosmic rays.

For these scholarly researches, educational institutions and scientific organizations of the highest rank, both in this country and abroad, have seen fit to confer on Dr. Millikan their highest honors, and in 1923 the Nobel Prize in physics was awarded him "for his works on the unit charge of electricity and on photoelectric phenomena."

In 1921 Dr. Millikan left the University of Chicago to assume the administration of the Norman Bridge Laboratory of Physics at the California Institute of Technology, and the present position of esteem which his school occupies is largely due to his rich professional experience, his exceptional mental gifts, and last but not least, to his winning personality, which has attracted to his laboratory student support as well as influential friendships.

Dr. Millikan has maintained an active and official interest in the work of the American Physical Society and the National Research Council, and served as president of the American Association for the Advancement of Science during 1929.

Dr. Millikan's public utterances of the last few years have been largely replies to the demand which the world always makes of the successful man to share with his less fortunate or less enterprising brethren the conclusions which he has drawn from life, the principles he has formed or salvaged, and the outlook he has attained. He has a very strong confidence in the future spiritual and material progress of the race, and in noting the human interest with which he discusses the part that science has played and is to play in that progress, it is a very pleasant thing indeed to realize that Robert Andrews Millikan, in growing to be a giant among scientists, has remained a man among men.

What Model Shall We Use?

WE ARE but lately in receipt of a letter which raises an old question, but one to which the teacher, and particularly the elementary teacher, must always give an answer of sorts.

Those of us who are attempting to teach chemistry on other than a purely empirical basis find that we must attribute the combination of elements and the interaction of compounds to some less vague and mystical influence than chemical affinity. In order to do so, we must give our students some concep-

tion of the nature of matter. And here the problem arises. Just what sort of a concept shall we present?

Obviously, it would be impossible to try to give elementary students any clear picture of what the atom is "really" like, even if we, ourselves, knew. If Heisenberg and others of the moderns are right, we shall never know.

And yet some sort of concrete model or picture is necessary if elementary chemistry is to be anything more than a course in memorization. Shall we compromise with our consciences and present to our students a model that we know to be wrong merely because it is simple and easy, or shall we give up the struggle and stick to "pragmatic" chemistry?

This is the way the problem appears to many teachers. But it seems to us (editorially speaking) that the real problem is greatly different. This is only a chimera, arising out of a state of mind.

It may have its origin in a sincere and commendable desire to transmit to students only the "truth," or at least the truth as we are given to see it. But that urge is in many cases sadly complicated by notions as to the exactitude of science and the desirability of maintaining an appearance of pedagogic infallibility.

Too many teachers, particularly young and inexperienced teachers, labor under the delusion that they must never admit ignorance or uncertainty before a class. Too many teachers, both old and young, are overly concerned with impressing upon their students the exactitude of science.

Science is not exact. Probably the best it can ever hope to arrive at is a close approximation to the generalities which would exactly predict the course of objective phenomena of all sorts. In fact, it now seems certain that there is a rather definite limit upon the closeness of all our approximations. If science has an outstanding virtue which should be impressed upon students, that virtue does not lie in exactitude—it lies in the scientific method of attacking a problem.

Why not, then, take the students into our confidence? Why not inform them that chemistry and physics are yet in their infancy, and that they are very healthy and fast-growing infants indeed?

Then when we have told our students that nobody now knows exactly what an atom is like and that probably no one ever will, shall we present to them in detail the latest model available and attempt to teach chemistry on the basis of that model? To us (again using the editorial plural) such a procedure seems both unnecessary and absurd.

If all models are admittedly inexact, and in all probability must always remain so, we can at once eliminate the concept of "reality" from our consideration and get down to the really significant question of utility. We should warn our students that the models and diagrams which we

shall use are not meant to be pictures of reality, but merely tools. Our real question then becomes, "What tools are best suited to the work in hand?"

If one contracts for the building of an apartment house, one need not furnish the builder with a scale model of the building; the architects' blueprints will do very well. These blueprints may be considered as roughly analogous to what the most advanced physicists know about the atom. They don't look much like a finished apartment house, but they do guide the builder in performing a great many operations.

When the building is placed in the hands of a renting agent, much less elaborate plans are necessary. Division of floor space and distribution of lighting are about all that the agent needs to know. His blueprints will be much simpler than the builder's. Just so, the atomic model which the elementary student of chemistry uses may be much simpler than the best which the physicists have yet constructed. The analogy is crude and unpolished, but perhaps it illuminates our point.

The atomic model in elementary chemistry, then, should be very simple—not solely, or primarily even, because a simple model is easy, but because only a very simple model is necessary to explain the facts encountered in elementary chemistry. It will of necessity be static, for dynamic models are difficult to construct and impossible to depict on the blackboard. When such a model is presented for what it really is—a working tool—it will create no false impressions which will have to be removed later if the student continues in chemistry. At the same time it avoids overwhelming the student with a superfluity of irrelevant detail, and so confusing the issues immediately at stake.

The question then resolves itself into a choice between two or three possible models, all of which are essentially the same. Obviously a detailed discussion of the possible choices is not appropriate to the editorial columns.

THE *Harvard Alumni Bulletin* summarizes the argument presented by Professor David Snedden in a recent article in *School and Society* in part as follows:

Scholasticism and Education Highly specialized scholarship has attracted an increasing number of able men and they wield a large influence in the making of school and college curricula. Their natural tendency is to insist on the value of the subjects they teach. They exert a strong pressure to have these subjects taught in school and college as wholes, in logical organization, and for their own sakes. They view their subjects as ends, not means. They want boys and girls to know these subjects fully, to pursue them from their very foundations, as if the object in view were scholarship itself, and to avoid any selection of special

parts and phases of a subject on the ground of their connection with a job, or with a hobby, or with health, or with citizenship, or with any other interest of life.

Here, it seems to us, Professor Snedden characterizes very clearly one of the dead weights which bears down upon the awakening interest in chemistry as an element in cultural education. Too many in positions of power appear to hold that the school or college is a medium for the presentation of subjects and that the student body is entirely incidental. If our educational institutions are to become and remain something more than a "refuge for (more or less) educated indigents," a wholesale conversion from this point of view will have to take place. Chemistry for the student, rather than for chemistry's sake, must become the slogan of the cultural course.

Nevertheless, the *Alumni Bulletin* adds a note of warning which may well be given some consideration.

> There is weight in this argument, but there are grave dangers in accepting it, without criticism, as a guide for education. The aims of education must be stated in terms of the effect of studies and school activities and influences on the student; the whole end in view is the making of a man. In its intellectual aspects, and especially in what may be called the moral aspects of intellectual effort, education cannot ignore the fact that scholarly ideals have in them something of value. If the student never studies any subject as a whole, in logical order, for the sake of knowing it as fully as possible on a given level, including its relations to other subjects and to his own various interests, he has missed a profoundly profitable intellectual experience.

However, this cautionary note should not be construed as refuting or nullifying any portion of Professor Snedden's thesis. The scholasticism against which he inveighs is scarcely synonymous with the scholarship which the *Bulletin* champions.

We should remember also that the scholarly ideal, like the scientific attitude, finds little soil for growth in many minds. And we should remember, furthermore, that no individual can hope to maintain the scholarly attitude toward all subjects about which it is good for him to know something. The world has grown entirely too complex to admit of any such catholic scholarship. About the best one can hope to acquire is an intelligent understanding of the fundamentals of the chief fields of human thought and knowledge, plus a more detailed and scholarly knowledge of one or two rather limited departments chosen from among them. Interest should determine the choice. Chemistry may not be, for many students, the proper medium for the cultivation of the scholarly ideal.

We cannot make scholars of any of our students in any quantitative sense in the span of a year's course. In a very few of them we may awaken or encourage the *ideal* of scholarship.

THE DIALYZER

1. What American physicist established the atomic structure of electricity by measurement of the unit charge? (pp. 974–6, 1198.)

(*For questions* 2–3 *see* pp. 981–99.)

2. What is the significance of the series of color changes obtained when tellurium is placed in a solution of sodium in liquid ammonia?
3. Discuss the nature of negative valences of metallic elements.

(*For questions* 4–7 *see* pp. 1000–27.)

4. Differentiate between the two types of cancer: (1) carcinoma and (2) sarcoma.
5. How is the problem of the investigation of the cause of cancer being attacked?
6. What progress has been made recently on the diagnosis of cancer?
7. What are some limitations to the alleged "cancer cures" of today?

(*For questions* 8–10 *see* pp. 1028–36.)

8. How does a dry-point plate differ from an etched one?
9. How are bank-note engraving plates made?
10. How is the color rotogravure produced?

(*For questions* 11–13 *see* pp. 1037–50.)

11. How are peanuts shelled commercially?
12. Have roasted salted peanuts in the shell been successfully prepared?
13. To what is sogginess in salted peanuts due?
14. What is the purpose of the new French Institute with which M. Jean Perrin is connected? (pp. 1051–7.)

(*For questions* 15–17 *see* pp. 1058–80.)

15. How does Millikan dispose of the hopes and fears aroused in various quarters by Soddy's "hobgoblin of dangerous quantities of available subatomic energies"?
16. How far is science responsible for the restless modern spirit of "change for the sake of change?"
17. How can the scientific spirit contribute to the spiritual progress of the race?

(*For questions* 18–24 *see* pp. 1081–99.)

18. Which one of two German chemists, renowned for their work on indium, actually discovered this element?
19. Who invented the Geissler cock?
20. What evidence do we have that Winkler and not Knietsch first made the contact process for manufacturing sulfuric anhydride a commercial success?
21. Under what conditions and by whom was the element germanium discovered?
22. Can you demonstrate to your class that while iron, cobalt, and nickel are attracted by a magnet at ordinary temperatures, only cobalt maintains this property at high temperatures?
23. Have you ever tried Bunsen's method for removing sticky precipitates from filter paper?
24. Have you ever heard how a hungry fly threatened to impair Bunsen's analytical reputation?
25. What can you contribute to the exhibits being planned for the Cincinnati meeting next September? (pp. 1113–4.)
26. What innovations are being made at Cornell for the training of chemical engineers? (pp. 1127–30.)
27. What was known about the preparation and action of antimony by the chemists of the 17th century? (pp. 1141–6.)
28. If you assigned the making of "Karo from Corn" as a laboratory project, what educational objectives would be attained? (pp. 1147–53.)
29. How is Tufts College planning to acquaint friends, graduates, and prospective students with the work of its chemical laboratory? (pp. 1209.)

LIQUID AMMONIA AS A SOLVENT AND THE AMMONIA SYSTEM OF COMPOUNDS. V. THE PROPERTIES OF SOLUTIONS OF METALLIC COMPOUNDS IN LIQUID AMMONIA[1]

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In the present article it is proposed to treat a very interesting class of substances which have been termed "metallic compounds." As the name suggests, these substances are binary compounds of one metal with another, and usually consist of a strongly electropositive element in combination with a weakly electropositive element. The latter has been termed "amphoteric," since, in the presence of a strongly electronegative element, it exhibits electropositive properties, and, in the presence of a strongly electropositive element, it is truly electronegative. The best known of the metallic compounds are those composed of elements such as sodium, potassium, lithium, calcium, etc., as the electropositive constituent, and metals of the fourth, fifth, and sixth groups—*e. g.*, tin, lead, arsenic, antimony, bismuth, selenium, and tellurium—as the electronegative constituent. Typical examples of these compounds are those represented by the following formulas: Na_4Pb_9, K_4Sn_8, Li_3As, Na_3Bi, K_2Se_3, Na_2Te_2. In their characteristic properties, the compounds containing the greater proportion of amphoteric metal closely resemble the familiar alkali polysulfides and polyphosphides. Again, some of the elements of the second and third groups which are not strongly electropositive may serve as the electronegative part of the metallic compound; *e. g.*, NaTl, Na_3Tl, $NaZn_4$, $NaHg_2$.

The study of metallic compounds has been greatly facilitated by the use of liquid ammonia. This solvent possesses certain properties which render it very valuable in the study and preparation of these compounds. To recall briefly, ammonia approaches water in its ability to dissolve inorganic compounds but differs in its much lessened solvolytic action, so that many substances, which are completely destroyed by reaction with water, form perfectly stable solutions in ammonia.[2] Furthermore, the alkali and alkaline earth metals dissolve abundantly in liquid ammonia (without appreciable reaction) to form blue solutions which, when dilute, are ionic in nature.[3] It is rather startling to find that many metallic compounds are very soluble in liquid ammonia forming stable solutions. It is likewise surprising that these solutions impart marked characteristic colors of green, brown, red, and purple, depending upon the particular compound under consideration.

[1] Previous papers in this series have appeared as follows: I, THIS JOURNAL, **5**, 664–70 (June, 1928); II, *Ibid.*, 828–35 (July, 1928); III, *Ibid.*, **6**, 20–35 (Jan., 1929); IV, *Ibid.*, 441–50 (Mar., 1929).

[2] *Ibid.*, **5**, 665, 669 (June, 1928).

[3] *Ibid.*, **6**, 20, 28 (Jan., 1929).

The results of the investigations of Kraus and co-workers upon metallic compounds dissolved in liquid ammonia are presented in the following pages. It is hoped to point out the bearing of these results upon our conceptions of the metallic state of matter.

The Preparation of Metallic Compounds

Metallic compounds are most simply prepared by melting together the constituent elements. In order that these elements may be taken in the proper ratio, it is necessary to know previously what compounds are formed between the two elements in question. A study of the melting-

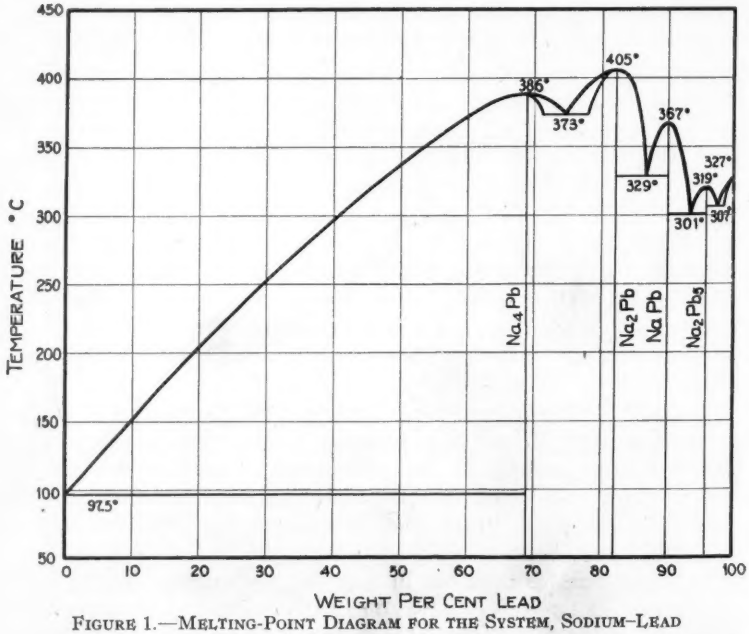

FIGURE 1.—MELTING-POINT DIAGRAM FOR THE SYSTEM, SODIUM–LEAD

point diagram of the two metals, *e. g.*, sodium and lead, will readily supply this information. Figure 1 is such a diagram; here there are plotted the melting points of all mixtures of these two elements. On the left side of the diagram is given the melting point of pure sodium, 97.5°. When metallic lead is added to the sodium, the melting point of the mixture appears higher than that of pure sodium. Finally, on the addition of more lead, a maximum melting point is obtained at 386° which is that of the first compound formed when metallic lead is added to metallic sodium. This maximum corresponds to a compound whose composition may be expressed as Na_4Pb; in other words, four atoms of sodium are combined

with one atom of lead to form a definite metallic compound. As the melts become richer in lead, the curves show that three other compounds are formed. These are shown by the three additional maxima, namely, at 405°, 367°, and at 319°. The compounds indicated by these maxima are Na_2Pb, NaPb, and Na_2Pb_5 respectively. The melting point of pure lead is given at the right side of the diagram as 327°.

When the equilibria between solid and melt of various mixtures of the two metallic elements have been determined, the compounds indicated by the curves may be readily prepared by heating the mixtures, having compositions corresponding to the maxima, above the temperatures of fusion. A steel bomb serves well as a container for the mixtures. It is essential that air and moisture be excluded as much as possible.

Several other equilibria have been determined by the method of thermal analysis to show that many metallic compounds are formed between sodium and less electropositive elements. The following table gives the compounds whose existence has been shown by this method of analysis.

TABLE I

Metallic Compounds between Sodium and Less Electropositive Elements as Shown by the Melting-Point Diagrams

Bismuth	*Mercury*	*Cadmium*	*Sulfur*	*Tin*
Na_3Bi	$NaHg_4$	$NaCd_2$	Na_2S	Na_4Sn
NaBi	$NaHg_2$	$NaCd_5$	Na_2S_2	Na_2Sn
	NaHg		Na_2S_3	Na_4Sn_3
	Na_3Hg_2		Na_2S_4	NaSn
	Na_5Hg_2		Na_2S_5	$NaSn_2$
	Na_3Hg			
Thallium	*Antimony*	*Selenium*	*Tellurium*	*Phosphorus*
NaTl	Na_3Sb	Na_2Se	NaTe	Na_3P
Na_2Tl	NaSb	Na_2Se_2	$NaTe_6$	Na_2P_5
Na_5Tl		Na_2Se_3		NaP_3
		Na_2Se_4		
		Na_2Se_6		

All the alkali and alkaline earth metals form similar compounds with these amphoteric elements; those given in the above table with sodium as the electropositive constituent merely serve as typical examples. It will be noticed that, in every instance, more than one compound is formed between the same pair of elements.

Liquid ammonia provides us with a means for preparing some of these compounds. Although the metals of the fourth, fifth, and sixth group elements are not soluble in liquid ammonia, they will, nevertheless, react with solutions of the alkali metals in this solvent. Some years ago Joannis[4] observed that mercury, lead, antimony, and bismuth react with

[4] Joannis, *Compt. rend.*, **113**, 795 (1891); **114**, 585 (1892).

alkali metals in ammonia solution. He concluded from his experiments that the compounds formed were, respectively, $NaHg_4$, $NaPb_2$, Na_3Pb, Na_3Bi, and Na_3Sb. It is now known that the alkali metals also react with selenium, tellurium, tin, arsenic, phosphorus, etc., to form many definite compounds. Joannis' results show only the compounds of the simplest type, usually the normal valence compound, but later experiments by other investigators[5] show that in practically every instance a series of compounds may be obtained which are decidedly more complex in nature. It appears that the first compound formed, in which the proportion of the alkali metal is the highest, is usually less soluble in ammonia than the other compounds of the series in which the electronegative constituent is present in greater amounts. All solutions of these metallic compounds are highly colored.

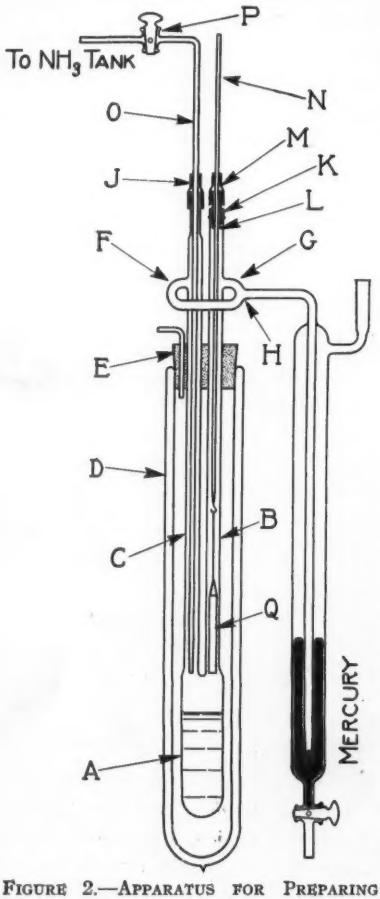

FIGURE 2.—APPARATUS FOR PREPARING METALLIC COMPOUNDS IN LIQUID AMMONIA

The methods employed in the preparation of these compounds in liquid ammonia solution are relatively simple. The apparatus must be so designed that air and moisture are excluded to prevent oxidation and hydrolysis. A very convenient type of apparatus was used by Kraus and Chiu[5a] for the preparation of the sodium mono-, di-, and tetra-tellurides (Figure 2).

Ammonia is first condensed in the reaction chamber *A* which is maintained at the temperature of boiling ammonia, —33.4°, by means of the Dewar bath *D*. A known amount of sodium[6] is then introduced

[5] (*a*) Kraus and Chiu, *J. Am. Chem. Soc.*, **44**, 1999 (1922); (*b*) Smyth, *Ibid.*, 39, 1299 (1917); (*c*) Kraus and Zietfuchs, *Ibid.*, **44**, 2714 (1922); (*d*) Peck, *Ibid.*, **40**, 335 (1918).

[6] The colors of concentrated and dilute solutions of sodium in liquid ammonia are shown by Figures 3 and 4, respectively. See THIS JOURNAL, **6**, 21 (Jan., 1929).

FIGURE 3—CONCENTRATED SOLUTION OF SODIUM IN LIQUID AMMONIA

FIGURE 4—DILUTE SOLUTION OF SODIUM IN LIQUID AMMONIA

into the same chamber where it is allowed to dissolve. A tellurium stick *Q*, which is connected by means of a wire to the glass tube *N*, may then be lowered into the sodium solution to react. When the reaction has proceeded to some definite stage, which is usually determined by color changes and the appearance or disappearance of some phase, the tellurium stick may be raised out of the solution, washed with ammonia and removed from the reaction tube. It is then weighed and the amount of metal that has reacted with the sodium solution is determined by difference. From this value and the known amount of sodium in solution, the composition of the compound dissolved or precipitated may be calculated.

The striking color changes in the reaction of tellurium with sodium in ammonia indicate the formation of different compounds and serve as excellent examples for illustration. As soon as the tellurium stick is lowered into the blue solution of sodium, a white precipitate is formed, and, as the reaction proceeds, the solution becomes a green, yellow green, then yellow and almost transparent, and finally, violet-purple and red. This final stage indicates that all of the sodium has reacted. It has been shown that the white precipitate is the normal telluride, Na_2Te. This substance, which is slightly soluble in ammonia, reacts with additional tellurium to form a very soluble, complex telluride having the composition, Na_2Te_2. This stage of the reaction is realized when the sparingly soluble Na_2Te has just disappeared. During this reaction the yellow solution first becomes brown, then green and gray, blue and transparent, and finally, violet-purple. When the normal telluride has just disappeared, the solution assumes its final color, a deep red. Some of these striking colors are shown in Figures 5 and 6.[7] The equilibrium between the complex, Na_2Te_2, and metallic tellurium may be reached by again introducing the tellurium stick and allowing reaction to take place. Experiments have shown that the final product is Na_2Te_4 since the solution contains two atoms of tellurium for every atom of sodium.

It would be impossible to describe here the preparation of the numerous metallic compounds which have been carried out in liquid ammonia solution. The preparation of the tellurides of sodium is characteristic of the general procedure, although the method may be varied somewhat to satisfy the properties of the compound under consideration. The amount of research which has been carried out with these solutions is quite limited, although varied. The nature of these solutions may best be illustrated by describing some of the significant experiments.

[7] The colors shown in these two figures are characteristic of sodium telluride solutions. Most of the sodium-tin compounds impart a bright red color to the solution (see Figure 7, solution of Na_4Sn_8 in ammonia). Compounds of sodium with lead are green in liquid ammonia while those of sodium with antimony are red. These colors are, however, dependent upon the concentrations of the dissolved compounds.

FIGURE 5—SODIUM TELLURIDE COMPLEX IN LIQUID AMMONIA

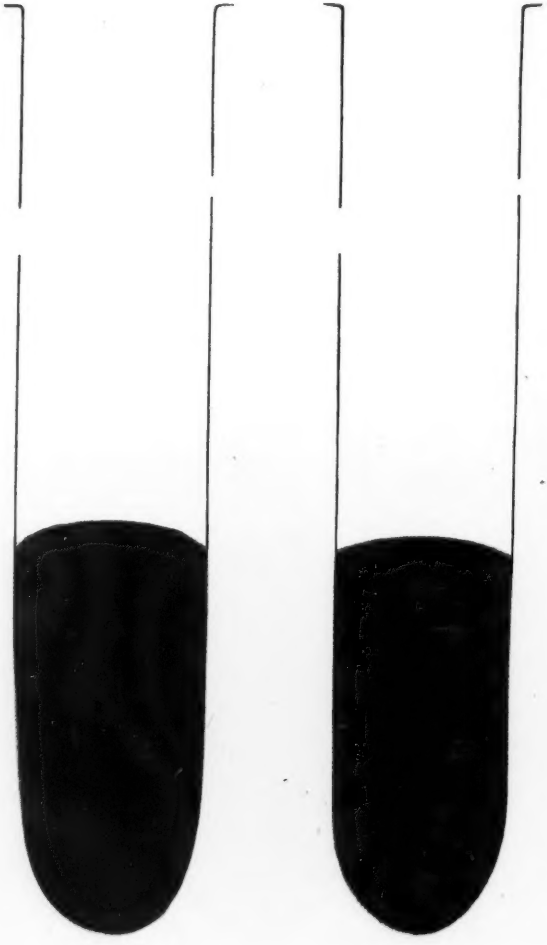

FIGURE 6—SODIUM TELLURIDE COMPLEX IN LIQUID AMMONIA

FIGURE 7—SODIUM STANNIDE, Na_4Sn_3, DISSOLVED IN LIQUID AMMONIA

The Conductance of Solutions of Metallic Compounds in Liquid Ammonia

The few investigations of the conductivity of solutions of metallic compounds in liquid ammonia clearly demonstrate that such solutions are electrolytic in nature. Kraus[8] examined solutions of sodium-lead compounds and found that they behaved differently from those of the alkali metals. Using a solution of a compound of approximately the composition represented by the formula $NaPb_2$ or Na_4Pb_8, Kraus found that, on electrolysis, with a stick of lead as the cathode, lead was deposited at the anode as rapidly as it went into solution at the cathode. Clearly, then, the anion furnished by the compound must be composed of lead. Later, Smyth[5b] studied this problem from a quantitative standpoint and was able to show that the compound in solution in equilibrium with metallic lead is Na_4Pb_9. On electrolysis of solutions containing these two elements at various concentrations, 2.25 gram atoms of lead were always deposited at the anode for every gram atom of sodium liberated at the cathode. If it be assumed that the lead anion is functioning with a normal negative valence of four, the composition of the sodium-lead complex in solution may be expressed by means of the formula, Na_4Pb_9. It also appears from the experiments that the amount of lead deposited per unit of electricity is independent of the concentration of the constituents in solution.

Rough determinations of the solubility of lead in a solution of sodium in liquid ammonia signify that a complex is present in which two or more atoms of lead are in combination with every atom of sodium.

Knowledge of the nature of these solutions has been further substantiated by Kraus and Kurtz[9] who have carried out some conductance measurements with solutions of potassium-lead mixtures in ammonia. A weighed amount of potassium was added to liquid ammonia, together with varying amounts of lead filings, and the solution was stirred until reaction was complete. The resistance of the solution was then measured and the equivalent conductance was calculated from the data. The results

TABLE II

The Conductance of Solutions of Potassium-Lead Mixtures in Liquid Ammonia

Diln. in liters per g. atom K	*Lead added, grams*	*Composition*	*Equivalent conductance*
13.3	0.1361	K_4Pb	330.0
13.3	0.0688	$K_4Pb_{1.5}$	238.5
14.45	0.1353	$K_4Pb_{2.5}$	179.6
15.97	0.2041	KPb	99.2
15.97	0.5450	KPb_2	46.3
17.12	Large excess	$KPb_{2.25}$	21.3

[8] Kraus, *J. Am. Chem. Soc.*, **29**, 1563 (1907).

[9] Kraus and Kurtz, *Ibid.*, **47**, 43 (1925).

of the conductance measurements are given in Table II. The dilution, in liters per gram atom of potassium, is given in the first column; the weight of lead added, in the second column; the mean composition of the solution, in the third column; and the equivalent conductance, in the final column.

The conductance values for compositions rich in potassium appear remarkably high. The equivalent conductance of potassium nitrate at a dilution of 15.87 in liquid ammonia is only 92.9,[10] while that of metallic potassium in this solvent at the same dilution is 532.1.[11] It is unreasonable to think that the potassium plumbide will conduct the current with greater facility than does potassium nitrate. The high values obtained in the first three instances given in the above table may be accounted for by the presence of some free metallic potassium.

The Energy Effects Accompanying the Formation of Metallic Compounds

The interaction of two elements to form a compound is always accompanied by an energy change which manifests itself either in a liberation or an absorption of heat. In general, the more electropositive the positive constituent and the more electronegative the negative constituent, the greater is the energy change accompanying the formation of the binary compound. The following equivalent heats of formation of compounds between calcium and electronegative elements bear out this fact:

CaF_2	$CaCl_2$	$CaBr_2$	CaO	CaI_2	CaS	CaSe	CaH_2	Ca_3N_2
119.4	92.0	77.4	72.5	70.6	45.4	29.0	23.1	15.4

The energy effects are expressed in large calories per gram equivalent. It is noticed that, as the negative constituent becomes less electronegative, the heat of formation decreases.

It is known that, in the preparation of metallic compounds by fusion of the two metals, a considerable energy change is involved. When, for example, a mixture of sodium and lead in equivalent gram atoms is heated to about 600° to form the compound NaPb, sufficient heat is liberated to maintain this temperature for several minutes.

Studies concerning the order of magnitude of these heat effects have been carried out with some degree of success. Biltz and Holverscheit[12] have determined the heats of formation of some metallic compounds of sodium with tin. The compounds were dissolved in a $FeCl_3$-HCl solution and the accompanying heat effects measured. From these data were calculated the heats of formation of the compounds from the solid elements. They

[10] (*a*) Franklin and Kraus, *J. Am. Chem. Soc.*, **27**, 199 (1905); (*b*) *cf.* THIS JOURNAL, **6**, 27 (Jan., 1929).

[11] Kraus, *J. Am. Chem. Soc.*, **43**, 755 (1921); *cf.* 10 (*b*), p. 29.

[12] Biltz and Holverscheit, *Z. anorg. Chem.*, **140**, 261 (1924).

obtained for $NaSn_2$, 15.0; NaSn, 11.0; Na_4Sn_3, 36.0; Na_2Sn, 12.0; and Na_4Sn, 21.0 large calories per gram molecule.

Attempts have been made to determine the energy effects due to the formation of metallic compounds by measuring directly the free energy of formation which, in general, will not differ greatly from the heat of formation. This problem has been attacked by setting up cells of the following type:

Dilute Na amalgam—NaI diss. in NH_3—Metal (Sn, Pb, Bi, Sb, etc.)

When such a cell is in operation, the metallic sodium goes into solution at the anode to give the normal sodium ion which migrates to the cathode to enter into combination with the less electropositive element which has acquired the electron. The potential of the cell measures the maximum amount of work, the free energy, involved in the formation of the compound $NaPb_x$, for example. The exact composition of the compound formed at the electrode is not known but it may be predicted to be the most insoluble one.

The results of measurements of the free energy of formation of several metallic compounds, by means of a type of cell outlined above, are given in the following table.[13] The values are expressed in large calories per gram atom of the electropositive element. One volt is equivalent to a little more than 23 large calories.

TABLE III

The Free Energy of Formation of Intermetallic Compounds

$NaPb_x$	$NaSn_x$	$NaSb_x$	$NaBi_x$	$NaTe_x$	$CaSb_x$	$ZnSb_x$
39.1	39.7	43.0	44.2	49.9	37.0	24.8

In the latter two cases, the electropositive constituents, Ca and Zn, were used directly as electrodes, while the remaining values were obtained by using either an amalgam of sodium or the metal itself. The amalgam is preferable since only a small amount of the sodium goes into solution; if metallic sodium is used directly, reaction takes place with the ammonia more readily.

The data given in Table III show that the energy effects accompanying the formation of these metallic compounds are remarkably high and indicate that the combinations are salt-like in nature. If we were to examine the heats of formation of alloys, in other words, the heat of solution of one metal in another, we would find that the energy effects are not very large. It is evident that in the former case we are dealing with a chemical combination. The heat of formation of sodium chloride per equivalent weight is about 98.0 kilogram calories and that of lead chloride is 42.7. Since

[13] Kraus, *Trans. Am. Electrochem. Soc.*, **45**, 175 (1924).

sodium is one of the most electropositive elements and chlorine is very electronegative, while lead lies intermediate in the series of affinities, it is reasonable to expect that the heat of formation of a true sodium plumbide would have a value of the order of magnitude of that of lead chloride or one-half that of sodium chloride, providing we make the comparison according to equivalent quantities. Of course, since most of these combinations involve the formation of a complex anion, there will be an additional energy change to express this, but the effect would be expected to be very small in comparison with the energy effect accompanying the formation of the simple or normal compound.

The Effect of Concentration on the Constitution of Solutions of Metallic Compounds

We have already seen that, in the case of the sodium-lead solutions, the equilibrium composition of the solution appears to be independent of the concentration of sodium and lead. In other words, there is obtained at equilibrium 2.25 atoms of lead for every atom of sodium in solution, which value appears to bear no relation to the sodium concentration. This statement may not be valid over a large range of concentration, we can merely remark that it is tenable over concentrations which have thus far been investigated.

The results of investigations on sodium-tellurium and also sodium-antimony solutions show that the ratio of sodium to the electronegative constituent does not remain fixed. In the case of the first system, at a concentration of sodium in the neighborhood of 2 *N*, the ratio of tellurium to sodium has a value of about 2.02, and this ratio remains very nearly constant to concentrations as low as 0.5 *N*, after which it begins to decrease as the concentration decreases.[14] The fact that the ratio of sodium to tellurium does remain constant at the higher concentrations of sodium may be accounted for by the low solubility of the normal telluride. When all of the Na_2Te has reacted with metallic tellurium to form the complex tellurides which are highly soluble, there is an apparent change in the composition of the dissolved compound with the concentration of sodium present.

In the case of the antimony solutions[15] a similar effect is noticed. The antimony to sodium ratio increases very rapidly with the sodium concentration in the dilute regions to a maximum of 2.3 at a concentration of 0.4 *N*. At high concentrations of sodium there is a slight decrease in the ratio of antimony to sodium. At still higher concentrations the antimony-sodium ratio undoubtedly does not change greatly; the ratio represents the presence of the compound Na_3Sb_7.

[14] Kraus and Zeitfuchs, *J. Am. Chem. Soc.*, **44**, 2714 (1922).

[15] Peck, *Ibid.*, **40**, 335 (1918).

Many other systems of this type would doubtless show the same properties at certain concentrations of the dissolved constituents. The two above examples represent the only data available at the present time.

Reactions in Liquid Ammonia Solution

The physical chemical properties which have already been pointed out for some metallic compounds suggest that they are salt-like in nature. This contention is supported by evidence obtained from studies on the chemical properties of the compounds dissolved in liquid ammonia.

Metallic compounds may be produced in liquid ammonia solution by the reduction of salts possessing a weakly electropositive cation. The reducing agent is best supplied by dissolving an alkali or alkaline earth metal in the solvent. A great number of these reductions have been studied by Kraus and Kurtz.[9] The general reactions may be expressed by the following equations:

$$MX_m + N = NX_n + M \quad (1)$$
$$nM + mN = M_nN_m \quad (2)$$

where M is the electropositive constituent of the salt having a valence m and N is the reducing metal with the valence n. The first reaction (1) represents the reduction of the salt to the free metal and the formation of the salt composed of the reducing metal as the electropositive constituent and X as the electronegative constituent. Equation (2) represents further action of the reducing metal on the precipitated metal M to form the metallic compound M_nN_m. The element M, which formerly existed in the electropositive condition in the salt MX_m, has been reduced to such an extent that it is electronegative in the metallic compound. Thus the compound, M_nN_m, is the normal compound with the electronegative element N functioning with its usual valence. The normal compound, however, is only one of many that may be formed between the two elements M and N. The amphoteric elements tend to form homo-atomic anions, that is, anions containing a higher percentage of the element N than can be readily accounted for by its valence.

The success of the reduction of salts by strongly electropositve elements and the subsequent formation of metallic compounds is dependent upon the solubility of the various constituents and products of the reactions. Several cases, which may be encountered, have been pointed out;[9] however, we shall confine ourselves to the two following cases:

(*A*) The reduced metal is capable of forming a stable anion with the negative electron.

(*B*) The reduced metal forms a complex anion (homo-atomic anion).

The following reactions are representative:

$$2Na + HgI_2 = 2NaI + Hg \quad (a)$$
$$Hg + Na = NaHg$$
$$2NaHg = Na + NaHg_2$$

$$2Na + ZnI_2 = 2NaI + Zn \qquad (b)$$
$$Zn + 4Na = Na_4Zn$$

$$TlI + Na = NaI + Tl \qquad (c)$$
$$2Tl + 3Na = Na_3Tl_2$$

$$2AgCN + Ca = Ca(CN)_2 + 2Ag \qquad (d)$$
$$Ag + Ca = CaAg$$

$$HgI_2 + Ca = CaI_2 + Hg \qquad (e)$$
$$2Hg + 3Ca = Ca_3Hg_2$$

Bergstrom[16] has shown that metallic compounds may be formed in liquid ammonia by the reaction of the alkali metal amides on such amphoteric elements as tin and lead:

$$10Sn + 6KNH_2 = 2SnNK{\cdot}2NH_3 + K_4Sn_8$$
$$11Pb + 6KNH_2 = 2PbNK{\cdot}2NH_3 + K_4Pb_9$$

The initial reaction of potassium amide and tin, for example, probably produces stannous amide[17] and the normal stannide, thus:

$$3Sn + 4KNH_2 = 2Sn(NH_2)_2 + K_4Sn$$

Stannous amide, being an amphoteric amide, reacts with the strong base, potassium amide, to form the salt, potassium ammono stannite,

$$Sn(NH_2)_2 + KNH_2 = SnNK{\cdot}2NH_3$$

while the normal stannide reacts with tin to form the polystannide,

$$K_4Sn + 7Sn = K_4Sn_8$$

Bergstrom has applied this type of reaction to many elements more electronegative than nickel and has pointed out that it is analogous to the following ones in water:

$$Cl_2 + 2KOH = KCl + KClO + H_2O$$
$$F_2 + 2KOH = 2KF + H_2O + {}^1/_2O_2$$
$$(2x + 2)S + 6KOH = 2K_2S_x + K_2S_2O_3 + 3H_2O$$
$$(2x + 1)Te + 6KOH = 2K_2Te_x + K_2TeO_3 + 3H_2O$$
$$(2x + 1)Se + 6KOH = 2K_2Se_x + K_2SeO_3 + 3H_2O$$

The value of employing the solvent ammonia at once becomes apparent when similar reactions involving the amphoteric elements are attempted in water solution. The following equations show the probable course of the reaction between tin and potassium hydroxide in water:[18]

$$3Sn + 4KOH = 2Sn(OH)_2 + K_4Sn$$
$$K_4Sn + 4H_2O = 4KOH + H_4Sn$$
$$H_4Sn = Sn + 2H_2$$
$$Sn(OH)_2 + 2KOH = K_2SnO_2 + 2H_2O$$

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[16] Bergstrom, *J. Phys. Chem.*, **30**, 12 (1926).

[17] Stannous amide, $Sn(NH_2)_2$, has never been definitely established although the imide, SnNH, the deammonation product of stannous amide, is known. See Bergstrom, *J. Phys. Chem.*, **32**, 438 (1928).

K_4Sn is readily hydrolyzed in water while in ammonia it is perfectly stable. The hydride, H_4Sn, is a very unstable compound and is not capable of existence in either medium.

The following reaction, which takes place readily in ammonia solution, shows that these compounds are ionic in character and behave as ordinary salts in any medium:

$$2Ca(NO_3)_2 + K_4Pb_x = Ca_2Pb_x + 4KNO_3$$

An extraordinarily interesting case appears when a solution of a lead salt, such as $PbCl_2$, is reacted with a metallic compound containing the lead in the anion.[13]

$$2PbCl_2 + K_4Pb_9 = Pb_2{\cdot}Pb_9 + 4KCl$$

In this reaction, a positive lead ion combines with a negative lead ion to give ordinary metallic lead. The charges on these two ions neutralize each other to form and precipitate metallic lead.

Metallic compounds are often found as products in various reduction reactions. Compounds, such as the halides, nitrates, cyanides,[18] sulfides, etc., of amphoteric elements may in many instances, depending upon their solubility, be reduced by strongly electropositive elements in ammonia solution. The amphoteric element in the free state will, in general, react with additional alkali metal to form a metallic compound.

The Electronegative Potential Series in Liquid Ammonia

It has been pointed out[13] that the elements may be arranged in two electropotential series, a series of electroaffinities of the elements in the electropositive condition and a series of the elements in the electronegative condition. The elements exhibiting amphoteric properties will have a place in each series:

| | | |

$$F_2 + 2KCl = 2KF + Cl_2$$
$$Cl_2 + 2NaBr = 2NaCl + Br_2$$
$$Br_2 + 2NaI = 2NaBr + 2I$$
$$Cl_2 + Na_2S = 2NaCl + S$$

These reactions are concerned only with the strongly electronegative elements. Since the less electronegative elements, namely, the amphoteric elements, form salts which are, in general, very reactive with water, the series of affinities of these elements were determined in liquid ammonia solution by means of a study of replacement reactions.[19] The potassium or sodium salt of lead, bismuth, tin, antimony, arsenic, phosphorus, tellurium, selenium, sulfur, iodine, and mercury was allowed to react in liquid ammonia solution with zinc, iron, copper, lead, bismuth, tin, antimony, arsenic, phosphorus, tellurium, selenium, sulfur, iodine, and mercury, as shown in the following equations:

$$xFe + Na_4Pb_9 = 4NaFe_x + 9Pb$$
$$9Sn + Na_4Pb_9 = Na_4Sn_9 + 9Pb$$
$$xSb + Na_4Pb_9 = Na_4Sb_x + 9Pb$$
$$xAs + Na_4Pb_9 = Na_4As_x + 9Pb$$
$$xP + Na_4Pb_9 = Na_4P_x + 9Pb$$

showing[20] that iron, tin, antimony, arsenic, and phosphorus are more electronegative than lead. According to the following equation antimony is more electronegative than tin:

$$xSb + Na_4Sn_8 = Na_4Sb_x + 8Sn$$

Likewise,

$$xP + NaSb_y = NaP_x + ySb$$
$$xTe + NaSb_y = NaTe_x + ySb$$

and so on through the entire series of elements listed above. By means of these displacement reactions, Bergstrom has formulated an electronegative series of the elements in liquid ammonia solution which is substantially the same as the reverse order of the electropositive series in water in the range of the amphoteric elements: lead, bismuth (?), tin, antimony, arsenic, phosphorus (?), tellurium, selenium, sulfur, and iodine; with lead being the least electronegative and iodine the most electronegative of this group.

The Nature of Metallic Compounds

There is no doubt regarding the fact that the metallic compounds which have been discussed in the preceding paragraphs are true electrolytes when dissolved in a suitable solvent such as liquid ammonia. They are readily electrolyzed in solution and appear to conduct the current with considerable facility. Many of the metathetic reactions which have been

[19] Bergstrom, *J. Am. Chem. Soc.*, **47**, 1503 (1925).

[20] Some of the above equations represent true equilibrium conditions. Whether or not reaction proceeds is dependent to some extent upon the concentration of the constituents.

cited indicate that we are dealing with substances which possess properties analogous to the typical electrolytes dissolved in ammonia as well as in water. The reactions proceed in most cases with extreme rapidity and very often go to completion. The data obtained for the energy effects accompanying the formation of these compounds substantiate the conclusions which have been made.

Kraus[21] has discussed clearly the nature of negative valences of metallic elements:

> According to present views regarding the structure of matter, elementary substances (excepting elements of the argon group) may be expected to exhibit either electropositive or electronegative valence. The conception has frequently been employed in accounting for the structure of compounds among non-metallic elements but appears not to have been extended to compounds among metallic elements. *A priori*, there is no reason why an element which ordinarily exhibits a fairly strong electropositive valence might not be expected to exhibit, likewise, a fairly strong electronegative valence. This is unquestionably the case with hydrogen which, in combination with strongly electronegative elements, appears to be positively charged, or, at any rate, is associated with the positive ion, while in the hydrides of the strongly electropositive elements it is negatively charged.
>
> The normal compounds of the strongly electropositive elements with sulfur, selenium, and tellurium are non-metallic. On the other hand, similar compounds with arsenic, antimony, and bismuth are metallic. The greater the atomic number of an element, and the farther it lies removed from the seventh group of elements, the more pronounced are the metallic properties of its compounds with more electropositive elements. So, the compounds of the alkali metals with antimony and bismuth are more metallic than those with arsenic and phosphorus. Similarly, the compounds of sodium with mercury and lead are more distinctly metallic than those with bismuth and tellurium. Sodium forms with antimony the compound Na_3Sb. There is no reason for believing that this compound differs essentially from the nitride Na_3N, or the phosphide Na_3P, on one hand, or from the sulfide Na_2S or the telluride Na_2Te, on the other. In the fourth group, lead and tin form stable compounds, Na_4Pb and Na_4Sn, in which these elements may be assumed to exhibit a negative valence of 4. It appears, then, that the elements of the sixth group exhibit a marked negative valence of 2, those of the fifth group of 3, and those of the fourth group of 4. The compounds in which the elements appear combined according to these proportions are relatively very stable, as is indicated by their melting-point diagrams and the heat effects accompanying their formation. While the compounds of the heavier metals of the fourth and fifth groups are metallic, those of the sixth group are non-metallic. It follows that the compounds of the elements of the various groups are essentially of the same nature. In other words, the property of metallicity does not involve a fundamental difference between the structure of such compounds and the structures of non-metallic compounds.
>
> A difficulty which confronts any theory of the constitution of metallic compounds lies in the multiplicity of compounds derivable from a single pair of metallic elements. Thus sodium and tin form the compounds Na_4Sn, Na_2Sn, Na_4Sn_3, NaSn, and $NaSn_2$. Writers on this subject have been misled in that they have looked upon the compositional formulas as indicative of the constitution of these compounds. When such writers have expressed an opinion as to the nature of such compounds they have, as a rule, been inclined to take the position that in these compounds the atoms are held together by

[21] Kraus, *J. Am. Chem. Soc.*, **44**, 1216 (1922).

forces essentially different from those operative in the case of non-metallic compounds.[22] Too much emphasis has been placed upon the proportions in which the various atoms combine. Apparently no attempt has been made to discover to what extent the various atoms entering into metallic compounds exist in the same condition; in other words, are all the tin atoms of this compound equivalent, or do these compounds possess a definite structure in which the relation of tin atoms to the sodium atoms differs for different atoms?

The argument will perhaps be clearer when it is recalled that the tendency of relatively electronegative atoms to form stable negatively charged complexes is very pronounced. Thus, we have such complexes as the sulfate ion, nitrate ion, chlorate ion, perchlorate ion, etc. In these complexes the elements are arranged in a definite manner under all conditions, whether in the solid or the fused state or in solution. Furthermore, the nature of these complexes is not materially affected by the nature of the electropositive constituent with which they appear. Very striking, for example, is the trinitride ion, N_3^-, in which three nitrogen atoms appear combined to form a stable, singly charged complex anion. This tendency of the electronegative elements to form complexes is one much more common than has hitherto been suspected. This is particularly true of complexes in which a single element is concerned. The most familiar example of this type of complex anion is the tri-iodide ion. It has been shown that it is a general property of the iodide ion to associate with itself two additional atoms of iodine to form a relatively stable complex. In solution an equilibrium exists between the simple iodide ion and the complex ion. In the solid state the iodides include MI, MI_3, MI_5, MI_7, MI_9, where M is an univalent element.[23] Among other elements which exhibit a similar tendency to form complex ions, only the complex sulfide ion has been studied extensively.[24] It has been shown that the normal sulfide ion takes up additional sulfur to form a series of complex anions, $S{\cdot}S^{--}$, $S_2{\cdot}S^{--}$, $S_3{\cdot}S^{--}$, $S_4{\cdot}S^{--}$, $S_5{\cdot}S^{--}$. Thus far, the complex sulfides have been studied only in aqueous solution;[25] however, this property of the sulfide ion to form complexes with additional sulfur atoms is not restricted to aqueous solutions, but is one common to sulfides in numerous solvents. There is evidence indicating that selenium and tellurium[26] similarly form complex ions, although only the complex telluride ion has been studied in some detail in aqueous solutions.[27] May we not infer that other elements than those of the sixth and seventh groups exhibit a pronounced tendency to form complex anions? This hypothesis would account, for the most part, for the large number of compounds formed from a single pair of metallic elements.

We may, indeed, proceed one step further and suggest that the atoms in an elementary substance do not function in the same manner. Is it not conceivable that many elements are, in effect, compounds in which certain atoms act electropositively and others electronegatively? This would account for many of the properties of the less distinctly electropositive metallic elements.

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[22] Tammann, "Lehrbuch der Metallographie," Leopold Voss, **1914**, p. 230.

[23] Abel and Halle, "Abegg's Handbuch der anorganischen Chemie," S. Hirzel, **1913**, IV, 2, p. 432.

[24] Kuster and Heberlein, *Z. anorg. Chem.*, **43**, 53 (1905); Kuster, *Ibid.*, **44**, 431 (1905); **46**, 113 (1905).

[25] Bergstrom has recently investigated these sulfides and similar selenides in liquid ammonia solution. See *J. Am. Chem. Soc.*, **48**, 146 (1926).

[26] The above paragraphs were written in 1922. The complex ions of tellurium have been studied more recently. See Ref. 5.

[27] Tibbals, *J. Chem. Soc.*, **31**, 902 (1909).

In the past the term "salt" has been restricted to non-metallic compounds having ionic constitution, namely, compounds exhibiting ionic properties in solution and in the pure state and showing no metallic properties.[14] Metallic compounds, on the other hand, have practically not been classified, and, for the most part, have been sharply differentiated from the salts. According to the views here proposed, there is no sharp line of demarcation between the salts and metallic compounds. The property of metallicity is a more or less accidental one, depending, of course, upon the nature of the elements present in the compound, and particularly upon the relative electropositiveness and electronegativeness of the constituents. In other respects, however, there is nothing to indicate any marked break in the physical and chemical properties of binary compounds between two elements, as we pass from ordinary salts to true metallic compounds. If one constituent is strongly electropositive and the other strongly electronegative, then the resulting compound is a typical salt which shows no metallic properties. As, however, the electropositiveness of one constituent and the electronegativeness of another constituent becomes less pronounced, the metallic characteristics become more accentuated and the resulting compounds exhibit metallic properties, except in the case of elements which are relatively very strongly electronegative and electropositive. Thus, practically, all the compounds of the halogens with other elements are either salt-like or neutral substances. It is only seldom that they show metallic properties.[28]

In the case of the elements of the sulfur group, the normal compounds with the alkali metals appear throughout to be non-metallic. Certain of the complex compounds, however, such as the tellurides, exhibit metallic properties even in the case of the alkali metals, as has already been noted. On the other hand, even the normal tellurides of the less electropositive elements, such as silver and lead, exhibit distinctly metallic properties. Indeed, we are not confined, here, to the tellurides; as is well known, the normal sulfides and even the oxides of many elements exhibit metallic properties in certain states as, for example, some of the iron oxides and some of the natural sulfides of lead. There is nothing to indicate that, in their constitution, these metallic compounds differ materially from similar non-metallic compounds which exhibit a salt-like structure. The structure of all such compounds, therefore, is essentially the same type, corresponding to that of normal salts, while the metallic properties are determined primarily by the relative electropositiveness and electronegativeness of the elements concerned in the compound. Metallic compounds should, therefore, be classed with the salts.

It is hoped that the preceding paragraphs have pointed out the importance of the study of metallic compounds in liquid ammonia solution. It is quite evident that the results of such studies have an important bearing upon our conceptions of the metallic state of matter. The data at our disposal are exceedingly limited at the present time, and, in order to better understand the true nature of these compounds, it will be necessary to carry out many extensive investigations upon their chemical and physical properties.

[28] It is interesting to note that in this connection cuprous iodide is a typical salt-like substance, exhibiting purely non-metallic properties in the pure state. It absorbs iodine in the solid state, however, yielding a substance exhibiting metallic properties which are a function of the amount of iodine absorbed. The greater the amount of iodine present in this system, the more do the properties resemble those of characteristic metallic substances. [Baedeker, *Ann. Physik*, **22**, 765 (1907); **29**, 566 (1909); Baedeker and Pauli, *Physik. Z.*, **9**, 431 (1908).]

RECENT WORK ON THE CANCER PROBLEM

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Introduction by Joseph Colt Bloodgood*

My chief reason for accepting the invitation of the editor to write an introduction to this brief, but splendid, picture of cancer research work in Europe, is to make a definite statement in regard to the organization of research work which has for its object the control of cancer in one way or another. Doctor Geschickter pictures things as they are in Europe. The conditions are about the same in this country. In both, the laboratories are isolated and, whether connected with universities or not, their relationship is not close. In both Europe and the Americas, the number of cancer research laboratories and distinct cancer clinics is too small and the number of cancer research students inadequate. The majority of the students are underpaid. Not only is the army attempting the control of cancer ridiculously small, but it is scattered, there is no real organization in each unit, nor is there any attempt at an organization of the units as a whole. The proof of this statement will be found in the report of the Lake Mohonk Cancer Convention in 1926, and the second, larger, gathering in London in 1928. The literature of the actual work in cancer research will be found in the *Cancer Review* published in London and in the *Index Analyticus Cancerologiae*, in Paris. In spite of the educational efforts which began in Europe in 1804 and have perhaps most energetically been pursued in the United States by the American Society for the Control of Cancer since 1913, the enlightenment of the people through the press and other means of communication has been successful only in a few localities. The registered areas, certainly in the United States and apparently throughout the world, published mortality statistics showing that cancer as a cause of death is on the increase and has gradually risen from the twentieth place nine years ago to second place in 1929.

My own studies since 1890 show that the education of the people, which brings them to the medical profession immediately after the first warning for diagnosis and treatment, increases the five-year cures from ten to fifty per cent. To have accomplished this, the enlightened individual must receive the very best surgery or the most expert radiation. Many of my own colleagues and friends in this country expressed the opinion that fifty per cent is too high a figure, but are ready to admit thirty per cent. Grant that education has accomplished an increase of twenty per cent, it is enough to justify further continuation of the efforts in every locality. The greatest criticism of cancer students—whether in the clinic or in the experimental laboratory—is that they do not enter as enthusiastically and

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intimately into the campaign of education, nor do the hospitals throughout the world, nor do the departments of health, nor as yet do the people or their representatives request the medical profession to pursue the educational control of cancer as far as possible.

The department of pathology, among the sciences of medicine, has not kept pace with the demands for the diagnosis of the changing microscopic pictures as cancer comes under observation at an earlier and earlier stage of its malignancy, or in the stage that precedes malignancy, when practically, for therapeutic purposes, it is a curable disease. Just as the majority of the medical profession has failed to realize or appreciate the value of giving the people correct information about cancer, so have the surgeons and pathologists failed to observe the changing clinical, gross, and microscopic pictures of cancer as it comes to them when the people are enlightened and properly informed.

Recent careful studies of the facts obtained in the histories of individuals who come under observation of experienced cancer students with recurrent and hopeless cancer—who have been enlightened individuals and who have sought the advice of the medical profession in the earlier stages and who have received *incomplete* surgery instead of the established complete surgery, or insufficient or improper radiation and not of a character now well established throughout the world—show that the number of these cases improperly treated in the earlier and more curable stages of cancer is so large as to justify bringing this evidence before the medical profession, so that changes can be made in our hospital standardization to such an extent that adequate and properly equipped cancer clinics will be established wherever necessary to meet the demands of all the people.

The chief criticism in regard to research from the beginning, and especially now, is the lack of organization and the lack of coöperation between all the sciences.

At the present time, in spite of all the work accomplished in all the cancer research laboratories throughout the world, there is no evidence that any of the leads briefly summarized as chronic irritation, transplantation of animal tumors, further studies of the Rous-Murphy filtrate, cultivation of normal and cancer cells, all types of investigation of cell function and metabolism will lead to a cure. The hope of the discovery of the cause, prevention, and cure of cancer belongs to no one science. It is possible a new science may have to be discovered. The practical conclusion is, there should at once be more coöperation and an attempt at better organization between all the sciences and investigating activities of the medical schools and universities throughout the world.

For some years, in Baltimore, we have had what is called the scientific advisory board of the Maryland Cancer Committee. At its annual

gatherings practically every medical science is represented. It has already discussed and settled a number of important problems. The most important result, however, was a meeting this year between the cancer research students and the department of chemistry of Hopkins, with the result that the chemical group is aiding us in the search for a vital stain with the hope that it will prove a differential stain for the cancer cell.

The discovery of a differential stain for the cancer cell will solve one of the most difficult problems in hospital organization today. The differential diagnosis, at the exploratory incision and with the immediate frozen section, between malignant and non-malignant cells is practically impossible in the majority of hospitals in the world today, and this is not recognized as it should be, because in the majority of the hospitals today their patients enter in the later and easily diagnosed stages of cancer. Should every individual in this country go to the nearest hospital the moment he or she is warned, then and only then would the medical profession in those clinics appreciate the difficulties in the diagnosis.

The same is true of lesions of bone in the X-ray film.

When Mr. Francis P. Garvan, through Mr. W. F. Keohan, generously offered to enlarge the Surgical Pathological Laboratory and to provide for research for a differential stain for cancer, I hesitated to accept until I was also promised aid in investigating to the fullest extent the records in the Surgical Pathological Laboratory and to increase the teaching force, so that we could take care of more volunteer students. We are already reaping the benefits of this financial aid. It is only fair to a number of my generous patients to record here that their annual gifts aggregate a sum equal to that given by Mr. Garvan and the Chemical Foundation through Mr. William W. Buffum, the manager of that Foundation.

Unless the cure for cancer is found accidentally, it will probably prove to be the most difficult piece of medical research ever undertaken, and I trust that all research students in all departments of cancer study will aid in thinking out methods of investigation and research.

I take the liberty to record here briefly my own point of view based on more than thirty years of study, familiarity with the literature, correspondence and personal contact with many men and women interested in the whole wide field of cancer.

The fundamental basis of cancer study was clinical until the discovery of the microscope, and during that period there were no cures, little or no improvement in treatment. It is remarkable what Velpeau did in his pathological and clinical studies without the aid of the microscope. In fact he made classifications that have stood the test of microscopic reinvestigation. After the development of cellular pathology started by Virchow and dependent upon differential staining of microscopic speci-

mens, the classification of benign and malignant neoplastic diseases made rapid advances, and has practically reached its limits today. Nevertheless there are still differences of opinion about the classification of such lesions as the giant-cell tumor, multiple myeloma, Hodgkin's disease, and so forth. But these studies did not advance rapidly the treatment of cancer. Without doubt, the operative treatment of cancer did not rest upon a pathological basis, but was made possible by anesthesia which allowed the long, painstaking dissections, and Lister's antiseptic surgery which made it safe to pursue these long dissections without the danger of blood poisoning from an infection of the wound. The surgery of cancer really began in 1884 with Billroth's resection of the stomach for cancer. This was followed by Halsted's conception of the radical operation for cancer of the breast in 1889 or earlier, then by Kraske's method of complete removal of the lower end of the rectum with the coccyx and a piece of the sacrum, and then by Werthheim's most radical removal of the uterus with its lymphatics for cancer of the cervix.

These surgeons who conceived these radical operations for cancer were trained surgical pathologists and knew, from actual pathological study, the extent of involvement of the malignant disease from the primary focus. I know of no exception to the rule that a surgeon who established a pioneer operation for cancer was a gross and microscopic pathologist. This statement is true today. To maintain the results from the operative treatment of cancer, the operator today must not only have the same skill as shown by Billroth, Halsted, Kraske, Werthheim and others, but the same knowledge of gross pathology. This type of surgery in that first decade to 1900 accomplished ten per cent of cures even in late cancer.

Today the operator has another burden and responsibility. The older surgeons did not need their pathology so much to know how to diagnose the cancer they were attempting to cure, but to conceive how much tissue in addition to the local growth must be removed by a most painstaking bloodless operation, in order to give the patient ten per cent chances of a cure. The operator today, if he wishes to increase the chances of a cure from fifty to more per cent and never to make the mistake of an incomplete operation for cancer, or too extensive and mutilating an operation for a local lesion that is not cancer, must either himself be a trained surgical pathologist, or have one constantly with him in the operating room, just as he has an anesthetist or assistants in the technic of the operation.

Microscopic pathology, therefore, is still the basis of successful operative treatment of cancer today. For this reason, in the Surgical Pathological Laboratory of The Johns Hopkins University, with our added income, we have been able to increase our teaching force so that we are actually teaching seventy-five to one hundred students—all volunteers—where before we could teach only twenty-five. The groups are limited to twenty-

five students. The Garvan Research Laboratory for the differential stain of the cancer cell adjoins the teaching laboratory. Research and teaching proceed together, and from the students who take the course in microscopic surgical pathology throughout the four years in the medical school, we hope to get our research students and future operating surgeons.

Although we have already developed, in many clinics throughout the world, the successful cultivation of the normal and cancer cells of animals, we have as yet not succeeded in doing so with the human cells.

With the help of the Chemical Foundation, this laboratory has been established and is working.

We hope to use the growing human cancer cell in our studies of the differential stains and many other as yet unsolved problems which may lead to the discovery of the cause, prevention, and cure of the uncontrolled cell activity called cancer.

For various experiments a well-established and uniform strain of animals, especially rats, are necessary. We are planning to create such a large establishment of experimental animals that we may meet the real demands for a larger cancer study.

It is my hope that as we become more and more familiar with the clinical, pathological, therapeutic, and research studies on cancer throughout the world, we will be able to pick out the best in the various clinics and laboratories and bring this type of investigation together in one great clinic, and demonstrate to other clinics the kind of an organization which promises most for the best control of cancer today, and most for the discovery of its cause, prevention, and cure.

I also venture the opinion that the most important thing that has happened to make this possible is the launching of a new journal on cancer by Mr. William W. Buffum, Manager of the Chemical Foundation, which has the approval of Mr. Garvan, the President of the Foundation, and the Trustees.

Charles F. Geschickter's Summary of Cancer Problem

The increasing popular interest in the cancer problem, stimulated largely by current newspaper reports, has resulted in a great diversity of opinion concerning the present status of work on the cause and cure of cancer. To the lay mind cancer is a single disease entity, and the heavy mortality for which it is responsible bespeaks uniform incurability. As a matter of fact neither of these assumptions is correct. There are as many different types of cancer as there are tissues in the body, the glandular tissues, such as the liver and the breast, giving rise to a group of cancers known as carcinoma, and the supporting tissues of the body, such as bone and various types of so-called connective tissues, giving rise to forms of cancer known as sarcoma. Neither the various forms of carcinoma nor sarcoma

are uniformly fatal, and cures may be established by complete removal early in the disease before the cancer cells in the tissue involved migrate elsewhere to other organs to start multiple new colonies known as metastases. The problem in the treatment of cancer at present therefore is not merely to cure those cases which come under observation early with the local disease, but to treat successfully those cases which have dissemination or metastases or are seen late when the disease is widespread. The quest for a cancer cure is thus complicated by the variability of the disease and its tendency to secondarily involve many different organs in the body.

Work on the problem of the cause of cancer is even more involved since it undertakes the explanation not only of how the usually fatal growths or malignant tumors of carcinoma and sarcoma arise, but also must account for the origin of the so-called benign tumors which resemble the malignant tumors in their cellular composition and in that they are abnormal growths of tissue which serve no physiologic purpose although they closely duplicate the structure of the organ in which they arise. Unlike the malignant tumors, however, the benign tumors are characterized by slow or arrested growth, and have no tendency to migrate to distant organs to produce metastases which result fatally. The benign tumors may persist without operative interference and although producing local disturbances may never kill while the malignant tumors are invariably fatal when left to pursue their natural course.

It is not always easy to determine the presence of a tumor arising in an internal organ, and even after the presence of the tumor is established, operation to remove a piece for examination under the microscope is often necessary to determine whether the growth is benign or malignant, and even with the aid of the microscope the distinction is not always easily made. Means for accurate diagnosis between benign and malignant tumors is still an important problem for cancer research workers.

The various lines of investigation in the cause, diagnosis, and cure of cancer have become so diversified, that a tour of investigation of the larger cancer laboratories in Europe as well as a first-hand acquaintance with work in this country is perhaps the only reliable means of estimating the present state of progress in this broad field of medical endeavor. In the following pages an attempt has been made to summarize the results of such an investigation conducted during a four months' stay in Europe.

I. Work on the Cause of Cancer

Progress in the realm of cancer research appears to be dependent upon a gradual accumulation of facts rather than upon revolutionary and outstanding discoveries. The accumulation of this information necessary to the support or revision of current conceptions in regard to the cause

of cancer requires new methods of research and experimentation, and it is in the gradual extension of such available methods that the greatest progress toward the goal of solving the cause of cancer is being made. Thus in the past decades methods of cancer investigation have passed from the pathologic technics of dead and fixed specimens to animal experimentation, and in more recent years from animal experimentation to a direct study of human material in its living state in the form of cell suspensions, and possibly to tissue culture. It cannot be said therefore that work on the cause of cancer is at a standstill merely because no new principle of tumor origin has been demonstrated. Thus, a survey of the cancer laboratories in Europe reveals uncertainty and speculation in regard to the cause of malignancy, and yet there is evidence everywhere of an attack upon the problem along more fruitful and scientific lines. The experimental methods used and not the theories of cancer met with will therefore receive chief emphasis in this report.

Two main lines of inquiry which have occupied the center of attention of workers on the cause of cancer for some years are the result of experimental work on laboratory animals (including mice, rats, and chickens). One of these lines of inquiry is directed toward the analysis of irritating chemical agents such as the coal-tar derivatives and is based on the experimental production of carcinoma in rats and mice by skin irritation with these injurious agents. The other field of inquiry is directed toward the analysis of tumor filtrates in the search for evidence of a sub-microscopic infecting organism or filterable virus, or for some growth ferment or biologic catalyst influencing cell reproduction. It is based upon the laboratory procedure of transferring the sarcoma in a chicken from fowl to fowl by means of a cell-free filtrate prepared from the tumor. The older field of experimentation is with tar cancer.

Carcinogenic Agents—Chemical Irritants Producing Cancer

Dr. Ernest L. Kennaway, chemical biologist at the Cancer Hospital Research Institute in London, is continuing his experiments with cancer production in mice by means of coal-tar derivatives (Figure 1). Attempts have been made to produce effective carcinogenic agents in the form of synthetic compounds in the hope of disclosing some common chemical basis to all of the cancer-producing irritants. So far, in the cancer hospital laboratories they have never produced cancer in an animal by any pure chemical substance, although complex substances such as coal tar will produce true, malignant tumors on repeated application. One branch of their work has been stimulated by the occurrence of bladder cancer in dye workers, but their attempts in the past five years to produce bladder cancer in mice and rats by dye injections have not been successful.

Workers in other laboratories, such as Dr. Carminati working under

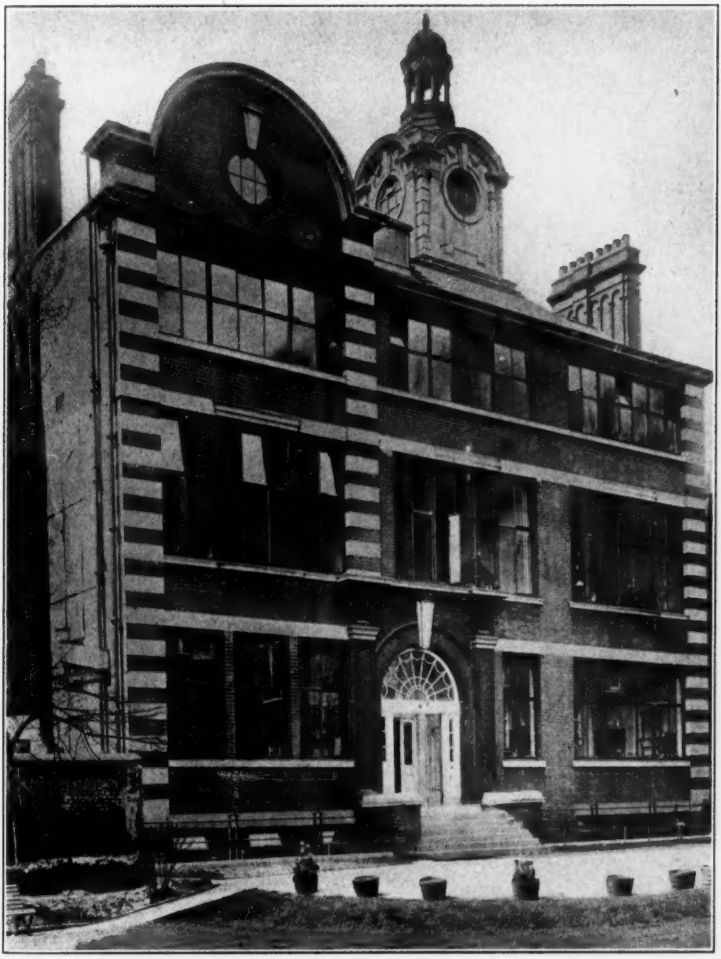


FIGURE 1.—THE CANCER HOSPITAL RESEARCH INSTITUTE ON FULHAM ROAD, LONDON, ENGLAND, UNDER THE DIRECTION OF DR. ARCHIBALD LEITCH
Dr. Ernest L. Kennaway's experiments on cancer production in mice by means of coal-tar derivatives are being conducted at this Institute.

Professor Pedro Rondoni of Experimental Biology in the Victor Emanuel National Institute in Milan, are conducting similar experiments with the coal-tar derivatives. However, in most of the European cancer laboratories the attitude toward this field of investigation is one of disappointment. This attitude does not detract from the value of tumor production

by carcinogenic agents as an experimental method, for it is proving a valuable tool in the hands of many investigators for the study of the earliest stages of cancer formation which may be thus produced.

From the standpoint of cancer causation, the results obtained from this method of tumor study lend weight to the time-worn theory of Virchow, that chronic irritation in tissues is a factor in cancer production, and would seem to indicate that the specific feature resides in some tissue change induced, rather than in the physical or chemical property of the injurious agent. No light, however, has been thrown upon the mechanism whereby the cancer change is instituted. One significant limitation of this method is that it is practically confined to external tissues such as the skin and has not been successfully applied to internal organs such as the stomach.

Tumor Filtrates

By far the most prevalent mode of study of the origin of cancer is that conducted upon tumor filtrates with the Rous chicken sarcoma.[1] The malignant, death-dealing nature of this tumor, as well as its inoculation from one fowl to another by means of a cell-free filtrate, is generally accepted by all cancer workers as proved. The search for the potent factor in the filtrate, however, continues. The hypothesis entertained widely some five years ago that the specific agent in this filtrate was some form of submicroscopic organism or filterable virus has been abandoned in practically all of the large centers of cancer investigation. The renewed interest in this subject has come from the experiments of Murphy at the Rockefeller Institute in New York, and of Luther Heidenhain in Worms, Germany.

Since Murphy startled the London Cancer Conference in 1928 by announcing that he had demonstrated by experiments on the Rous sarcoma that cancer is caused by a ferment or biologic catalyst capable of influencing cell growth many workers have sought to confirm his results. Among those engaged along these lines are Charles Sternberg in Vienna, Max Borst in Munich, Archibald Leitch, and James Murray in London. Murphy based his conclusions upon the production of sarcoma in chickens by the injection of extract of normal testicles. Leitch achieved the same results by injecting the extract of normal pancreas into fowls. But neither Murphy nor Leitch have been able to repeat their own experiments with constant results, and the work of other investigators has led to the conclusion that the effects of the extracts thus prepared were entirely nonspecific and the tumors produced either a chance occurrence or the result

[1] *Rous chicken sarcoma*—a sarcoma of the chicken known by the name of Rous sarcoma, because it was first described by Rous. [See Rous, *J. Exper. Medicine*, **12**, 696 (1910).]

of contamination with the Rous sarcoma filtrate. A similar interpretation is being placed upon the experiments of Carrel who obtained sarcoma in fowls by injection of arsenic and indol.

The work on tumor cell filtrates in cancer has been practically limited to the chicken and the production of chicken sarcoma, and for this reason skepticism is beginning to grow in regard to the conclusions drawn by experimentors in this realm in regard to human cancer. However, the work of Luther Heidenhain has been advanced in support of the conception that tumor filtrates have a wider significance. Heidenhain (see Figure 2) prepared an extract from a fatal human tumor composed of cartilage (chondrosarcoma[2]) and produced a very different but equally fatal growth (adenocarcinoma[3]) by injecting it into mice. On successive transplantations, this adenocarcinoma finally showed cartilaginous deposits and Heidenhain concluded that a specific tumor-producing agent had been present in his filtrate. This work of Heidenhain has not yet been confirmed. Borst in Munich, although skeptical, believes the experiments worthy of repetition. Charles Sternberg in Vienna was favorably impressed but Blumenthal in Berlin and Murray in London are inclined to the belief that the mouse tumor of Heidenhain was a spontaneous occur-

FIGURE 2.—A MICROPHOTOGRAPH SHOWING THE TYPE OF CELLS IN ONE OF THE TUMORS PRODUCED IN MICE BY HEIDENHAIN

This tumor was produced by a cell-free filtrate. The original filtrate was prepared from a fatal human tumor composed of cartilage, and was injected into a mouse with the production of a cancer of the breast. A second filtrate prepared from this cancer in the mouse produced this third tumor shown in the picture, which resembles in structure the original human tumor.

[2] *Chondrosarcoma*—a tumor composed of rapidly growing cartilage (or gristle) arising in bone, and hence a sarcoma.

[3] *Adenocarcinoma*—a malignant glandular tumor with cells arranged in ring-like formation.

rence and not the result of the filtrate prepared. It is hoped by some observers, such as Borst of Munich, that the Heidenhain experiments will bring the question of tumor filtrates to a crucial test, and determine whether or not this line of research is applicable to human carcinoma. Certainly, in view of the great vogue that the Rous tumor experiments have been enjoying, it is time that some reliable check was made to determine the value of the results obtained, from the standpoint of human malignancy.

Tumor Metabolism

The extension of biochemical methods to cancer investigation is largely due to Otto Warburg and his co-workers in the Kaiser Wilhelm Institute

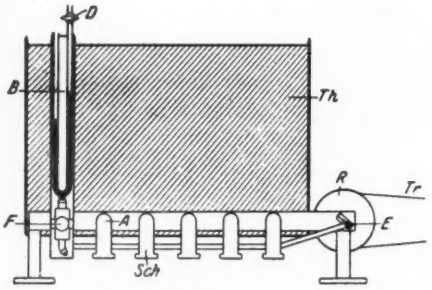


Abb. 2.

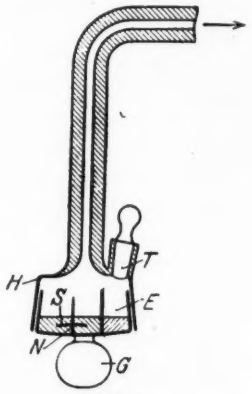


Abb. 3.

FIGURE 3.—THE APPARATUS USED BY WARBURG FOR THE MEASUREMENT OF THE METABOLISM OF LIVING TUMOR CELLS

The general view of the apparatus "Abb. 2" shows the manometer (*B*) connected with a shaking apparatus, the parts of which are indicated by the letters *Sch*, *R*, *E*, and *Tr*. The manometer is attached to the water bath *Th* and leads by a tube *D* to the tumor under investigation. The apparatus marked "Abb. 3" shows in greater detail the device for holding the tumor to be studied. The thin piece of tumor tissue *S* is immersed in a physiologic solution and held on a needle *N*. The glass container *E* and *G* is capped by the glass tubing *H* and *T*, which leads to the manometer shown in "Abb. 2."

of Biology in Berlin. Warburg by an application of the manometric methods (see Figure 3) of gas analysis of Barcroft to living tumor tissues has contributed valuable measurements on the metabolism of living tumor cells. These experiments conducted over a period of the last six years have shown that tumor cells utilize carbohydrate by two methods. One of these, combustion of sugar by means of the oxygen breathed, requires air and is termed aerobic. The other takes place without the aid of oxygen and is termed anaerobic. It consists of splitting sugar to lactic acid

(glycolysis) in the absence of oxygen. Both methods of carbohydrate metabolism are found in all tissues, but cancer tissue, according to Warburg's findings, is unique in the magnitude of its glycolysis, and even in the presence of oxygen this form of carbohydrate metabolism predominates with the formation of large quantities of lactic acid, which accumulate in a manner not found in other tissues. This glycolytic capacity of tumor tissue enables it to survive under anaerobic conditions, and upon this finding and the fact that tissues from the embryo also have a high rate of glycolysis, Warburg has constructed a metabolic theory of tumor origin. He postulates that embryonic cells[4] are sprinkled throughout normal tissue (probably for purposes of repair) and that when the tissue is subjected to an oxygen want by scarring of the vessels, injury, etc., the embryonic cells undergo a selective adaptation due to their glycolytic powers, and are capable of survival and perpetuation while the normal cells perish. These surviving embryonic cells with unusual glycolytic capacities constitute the malignant tumor.

FIGURE 4.—DOCTOR MAX BORST, PROFESSOR OF THE PATHOLOGIC INSTITUTE OF THE UNIVERSITY OF MUNICH

Professor Borst is one of the world authorities on the pathology of cancer and is author of "*Die Lehre von den Geschwülsten*," a two-volume work devoted to tumors, published in Wiesbaden in 1902.

Warburg's experimental methods have been applied to the cancer problem by various observers such as Robert Bierich in Hamburg, Dickens working under Professor Dodds at Middlesex Hospital in London, Crabtree with Murray in the laboratories of the Imperial Cancer Research Fund in London, workers with Borst in Munich (see Figures 4, 6*A*, and 6*B*) and others. The measurements made by Warburg on cell metabolism are generally agreed to but their specificity for cancer as well as their

[4] *Embryonic cells*—young unspecialized cells such as those found in the embryo.

theoretical implications are the subject of serious contention. Dodds and Dickens at the Middlesex Hospital are inclined to support Warburg in all but his theories in regard to cancer origin. On the other hand, Borst in Munich and Crabtree in London do not find that the metabolic features, emphasized as the peculiar property of cancer by Warburg, are specific for cancer. Warburg himself found retinal tissue from the eye to be an exception, and Crabtree has cited numerous infections with tissue over-growth which have identical metabolic features. Robert Bierich

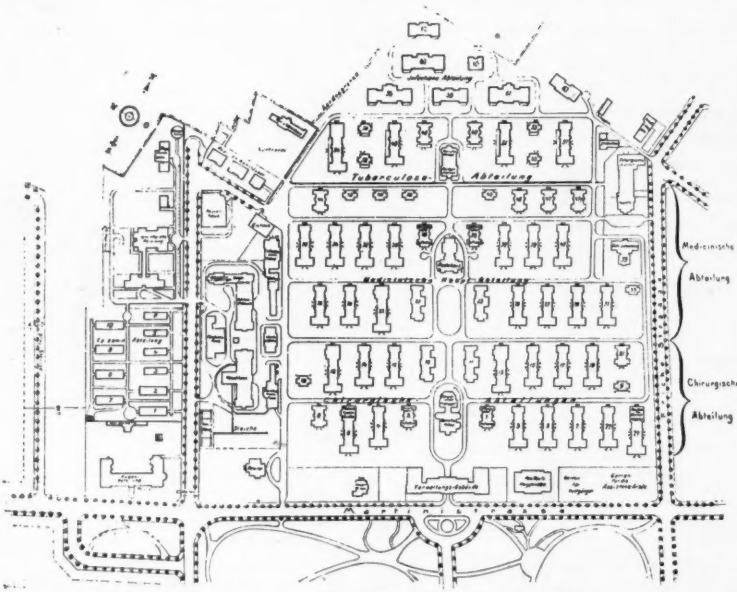


FIGURE 5.—GROUND PLAN OF THE EPPENDORF HOSPITAL AT HAMBURG, GERMANY, WHERE PROFESSOR ROBERT BIERICH IS CONDUCTING HIS EXPERIMENTS ON CANCER

The Eppendorf Hospital is one of the most complete in the world, built on the old-fashioned plan of providing individual pavilions for each department. It accommodates some two thousand patients and covers some sixty acres of beautifully gardened parks. The names of the various departments are seen on the plan.

is an outstanding opponent to many of the tenets of Warburg (see Figure 5). Bierich has repeated the experiments of Warburg and agrees with him that there is an unusual accumulation of lactic acid in cancer tissue. But, unlike Warburg, Bierich holds that the glycolytic rate of cancer tissue is normal, and that the unusual amounts of lactic acid are due not to its rapid formation but to the inability of the malignant cell to re-synthesize this acid to glucose. Bierich holds that glycolysis is a normal metabolic method in cancer and in all tissues and points out that the

FIGURES 6*A* & 6*B*.—FIGURE 6*A* (ABOVE) SHOWS THE OLD AND FIGURE 6*B* (BELOW) THE NEW PATHOLOGIC INSTITUTES OF THE UNIVERSITY OF MUNICH, GERMANY, IN WHICH THE CANCER WORK UNDER THE DIRECTION OF DR. BORST IS BEING CARRIED OUT

lactic acid thus produced acts as a normal physiologic stimulus initiating such processes as muscular contraction, glandular secretion, and "thinking" in the brain cell. In malignancy, however, Bierich finds in the excess lactic acid an agent whereby cancer tissue is able to destroy the fibers of normal connective tissue boundaries and thereby aid in the dissemination of the new growth. Bierich has confirmed experimentally this action of lactic acid on the fibers of connective tissue which are composed of a substance termed collagen. He holds that the findings of Warburg in regard to lactic acid in cancer must be considered merely as a symptom of the malignant cell and by no means the key to the essential nature of the cancer condition.

While it is evident that the specificity and the interpretation of the Warburg findings are open to conjecture, the applications of his experimental methods to cancer are being perfected and extended so that a steady growth of valuable information in regard to the metabolism of tumors can be expected. The impetus thus lent to the employment of biochemical methods in the study of the origin of cancer is, perhaps, Warburg's most important contribution. The bio-chemical work on the cancer problem thus stimulated, however, is seriously handicapped by the difficulty of choosing the proper type of tissue for metabolic measurements. Every tumor is a mixture of young actively growing tumor cells, old inactive tumor cells, and numerous normal cells which are poured into the tumor as part of the bodily defense against it. Obviously it is only the young active tumor cells which form the cancerous component of the tumor and biochemically it is very hard to study these cells independently without having the results obscured by admixtures of cells of the other two types.

General Systemic Causes in Cancer

It is surprising how many workers are turning to the view that cancer begins as a general systemic disease, and this in spite of the clinical fact of repeated cures by amputation or local excision of the growth. Behind this belief is the gradual accumulation of evidence pointing to the fact that a complex of causes must be present to initiate a malignant tumor. This point of view is suggested by the failure of experimentation to isolate a single invariable factor in the origin of cancer. Although tar derivatives will precipitate a skin tumor in mice, these injurious agents are neither constant nor essential factors as we have seen in the investigations cited, and in the same way, although a filtrate will transmit chicken sarcoma, it is insufficient for the perpetuation of tumor transplants in other animals. The analysis of human tumors by pathologic methods has similarly failed to yield a uniform incipient stage and only occasionally

are nests of cells misplaced in embryonic life or some factor such as trauma to be found in the history of the case.

European investigators find little satisfaction by calling into play a hereditary predisposition, and the experiments of Maude Slye in America bearing on this point are received with much skepticism. The formulation of other general systemic factors, however, is proceeding with great difficulty.

Some investigators conceive of resistance to cancer in terms of the reticulo-endothelial system[5] and it is intimated that in some way a suppression or over-taxation of the functions of this system predisposes to cancer. In support of such a conception, Brüda at Graz, Austria, working in Pfeiffer's Clinic, has injected foreign particles (such as India ink and trypan blue) into mice in order to saturate the reticulo-endothelial system and throw it out of function. He believes that he has demonstrated that these animals are more susceptible to cancer transplants than the controls.[6] Charles Sternberg at Vienna, however, has been unable to confirm these results. H. Auler in Blumenthal's clinic is devoting himself to a study of the serum and immune reactions of the blood of cancer patients in the hope of demonstrating some factor in the general circulation important in the causation of cancer. He believes that he has found a basis for the assumption that cancer is a general systemic disease in the behavior of the serum of cancer patients in the presence of cancer cells. The nature of these reactions will be disclosed in a forthcoming publication in the *Zeitschrift für Krebsforschung.*

No discussion is given here of the influence of the glands of internal secretion on the origin of cancer, or the theory that a general infestation with some virus is a fundamental factor in cancer causation, as no experimental work in the support of either hypothesis has been met with. It is important to note here, however, that many workers are tacitly couching their conceptions of the resistance or non-resistance to cancer in terms of immunology borrowed from the field of bacteriology, although most of them are unwilling to admit for cancer an infectious origin.

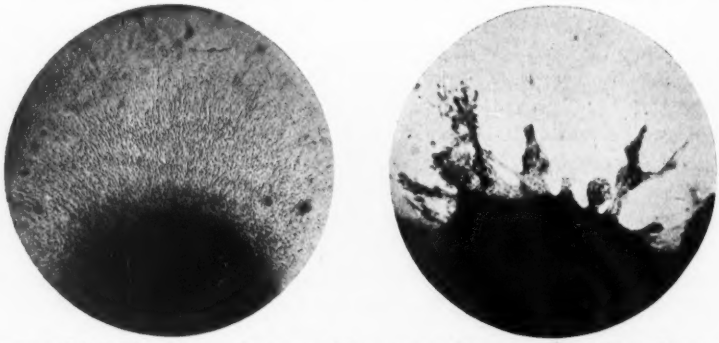
Tissue Culture of Tumors

At the time of the present writing no one has yet succeeded in maintaining a growth of human tumor cells for an indefinite period outside of the

[5] *Reticulo-endothelial system*—this refers to a group of cells found in the liver, spleen, and nodes of tissue about lymph vessels (called lymph nodes). These cells are active defensive agents and engulf and digest foreign particles which get into the circulation.

[6] As will be shown later the work of Brüda is diametrically opposed to that of W. Munck who claims to have produced a retarding influence on the growth of transplanted tumors in mice by use of the same particles—trypan blue—as a chemotherapeutic agent.

body (see Figures 7*A* and 7*B*). But the culture of tissues of animal tumors *in vitro* is being practiced and improved in most of the large cancer laboratories in Italy, Germany, England, and France, with a few outstanding exceptions. The newer methods of using heterogeneous sera (sera from several different animals in the culture fluid) and Albert Fischer's method of growing an admixture of connective tissue cells with the tumor to prevent autolysis[7] of the media, seem to offer definite hopes for the future *in vitro* of human tumors. The perfection of such a technic should prove a valuable experimental method in cancer study since it would



FIGURES 7*A* & 7*B*.—TISSUE CULTURES MAINTAINED OUTSIDE OF THE BODY SHOWING THE GROWTH OF HUMAN CELLS

Figure 7*A* (left) shows a culture of human adult fibrous tissue in which the cells are essentially normal and can be seen growing out into the medium like sun-rays from the dark circular area of the original piece of tissue. Figure 7*B* (right) shows a higher magnification of growing cancer cells, taken from a human breast cancer growing out in small branches from the dark area of the original tissue. These cultures were grown by Mr. George Gey, who is experimenting with the culture of human cancer tissue, at the Garvan Cancer Research Laboratory and Surgical Pathological Laboratory of The Johns Hopkins University and Hospital.

permit manipulations upon living human tumor cells not feasible in the patient.

While most of the tissue cultures of tumors have been utilized in testing proposed methods of treating cancer some of the experiments in this field have been directed toward solving the cause of cancer. Dr. Klee-Rawidowicz working with Dr. Hirschfeld at the *Universitäts Instituts für Krebsforschung* in Berlin finds that the repeated culture and subculture of rat and chicken sarcoma may be maintained for a year outside of the animal body and the final cultures reinoculated into animals without change in the properties of the tumors thus produced. This ability of the original tumor to maintain its characteristics in isolation outside of the animal body seems to speak against any systemic controlling factors and favors the view

[7] *Autolysis*—digestion of tissue or its products by cell secretions.

that cancer is a local tissue disease at its inception. The extent of the experiments in this direction is as yet by no means conclusive.

II. Work on the Diagnosis of Cancer

No new form of cancer diagnosis applicable to all forms of this disease has been added in recent years, and no one form of diagnosis has proved sufficiently accurate to displace the element of personal judgment. The quest has therefore been in the direction of more accurate and more widely applicable methods, and in this quest the viewpoints of the medical internist, the radiologist working with the X-rays, and the surgeon have cooperated. In the realm of the internist or specialist, the bronchoscope, the proctoscope, the oesophagoscope, the cystoscope,[8] and other methods for the direct visualization of internal organs have done much for the early diagnosis of cancer in the regions of the body where such instruments may be utilized. The specialization required for the use of most of these instruments as well as the clinical experience necessary to the making of a satisfactory diagnosis has urged forward the search for a serum reaction which would be available for the diagnosis of all forms of malignant disease.

Blood Serum Diagnosis

The search for a specific reaction in the blood of cancer patients for the diagnosis of cancer has been under way for some years, and many workers have devoted themselves to the problem. None of them has been rewarded with any practical success despite the variety of the tests proposed. Dr. Carminati working in Dr. Fichera's Institute in Milan (see Figures 8 and 9), Dr. Auler at Blumenthal's Clinic, and Dr. Fry working under Leitch at the Cancer Hospital in London are among the workers still engaged in this undertaking. Dr. Carminati has attempted to develop a diagnostic test for cancer by the action of the dye Sudan III upon the white blood cells of cancer patients with negative results. Dr. Fry has developed a test on the basis of a flocculation (precipitation) reaction when dried extract of cancer tissue (breast cancer) plus cholesterol is brought into contact with the patient's blood serum. In this method there is still a double source of error of false negatives or false positives in thirty per cent of the cases. Dr. Auler's experiments employ factors similar to the Wassermann reaction for syphilis and have not yet been published.

Some of the best informed biochemists in the realm of cancer investigation (such as Dodds and Bierich) conversant with these reactions and sim-

[8] These scopes consist of a long metal tube carrying a small electric light and mirrors, enabling the observer to visualize the organ for which they are named. The bronchoscope and oesophagoscope are inserted through the mouth and permit examination of the wind pipes and the gullet, respectively. The proctoscope visualizes the rectum and the cystoscope the bladder.

ilar tests such as those proposed by Hirsch and Abderhalden are extremely skeptical of their possibilities. Should it be proved that cancer begins as a local tissue change, then the probabilities of developing a reliable test on the basis of by-products cast into the general circulation by way of the blood or lymph vessels become extremely small when the disease is in its earliest stages. However, should the contention of some investigators, that cancer begins as a general systemic disease, prove correct, this method of diagnosis should have definite possibilities.

FIGURE 8.—PROFESSOR GAETANO FICHERA, DIRECTOR GENERAL OF THE NATIONAL INSTITUTE OF VICTOR EMMANUEL III FOR CANCER IN MILAN

Professor Fichera is editor-in-chief of the important Italian publication, "*Tumori*," on cancer and in an elaborate treatise published in that journal in 1911, presented a widely accepted theory on the origin of tumor growth.

X-Ray Diagnosis

At present, no new method applicable to the field of X-ray diagnosis is being widely advocated, and the special technics of air injection into the cavities of the brain, Liopidol injections into the respiratory tract and the Graham gall bladder dye which is excreted in the bile, while being more widely used in the various clinics, have not been added to or replaced by any method of special significance for the diagnosis of cancer. Nothing more has been heard of the X-ray technic of Kotzareff and Weyl of Geneva for cancer diagnosis mentioned in E. F. Smith's report on cancer research in *Science*.[9] This method which utilized the injection of radio-colloidal substances with a selective fixation in cancer cells, that could be registered on a sensitive photographic plate, has apparently been abandoned.

Immediate Microscopic Examination of Fresh Tissues in the Operating Room

One of the most valuable aids to the diagnosis of early cancer developed in recent years has been the method of freezing freshly excised tissue and

[9] *Science*, **61**, 1595–601 (June 12, 1925).

FIGURE 9.—A GENERAL VIEW OF THE NATIONAL INSTITUTE OF VICTOR EMMANUEL III FOR THE STUDY AND CURE OF CANCER IN MILAN, ITALY

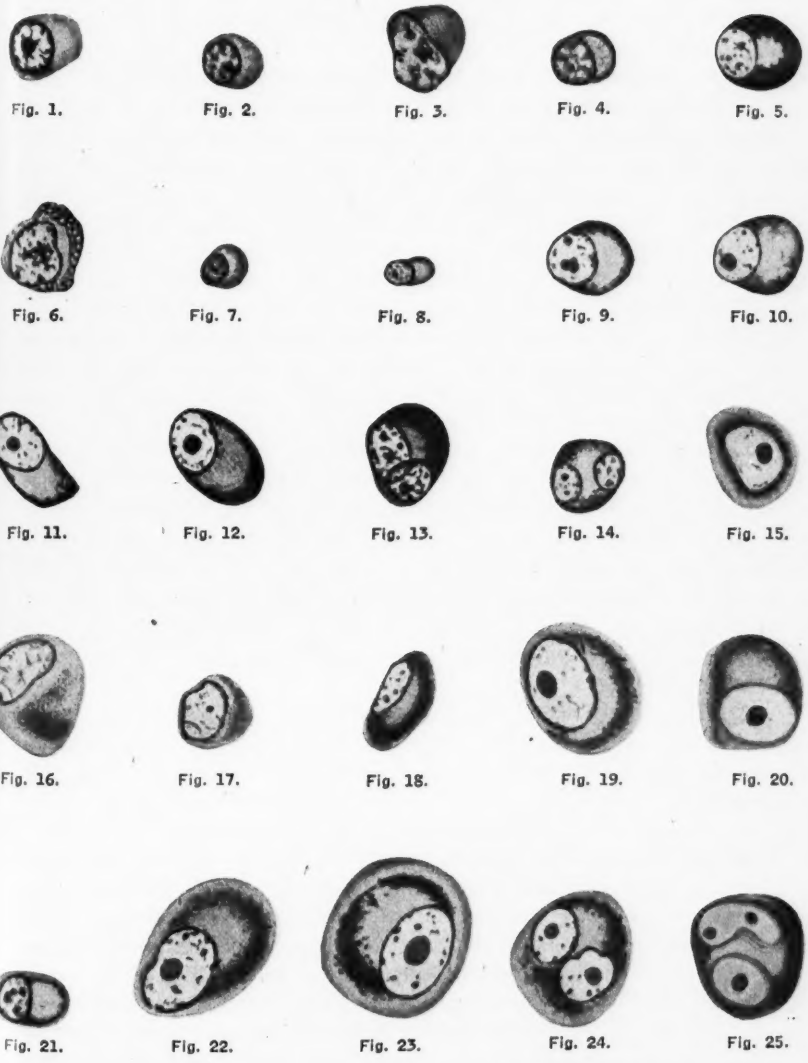
The Institute provides 230 beds for cancer patients and houses an elaborate equipment for X-ray and radium therapy and numerous facilities for research and experimentation. The Institute is part of the University of Milan, is only a little over a year old, and is architecturally one of the finest of its type.

FIGURE 10.—PROFESSOR B. LIPSCHÜTZ AT WORK IN HIS LABORATORY AT THE FRANZ JOSEPH HOSPITAL IN VIENNA, AUSTRIA

Dr. Lipschütz is one of the world's outstanding cytologists, and has demonstrated unique findings in regard to the structure of cancer cells. In previous years he has made many contributions to the study of diseases of the skin.

cutting sections for immediate microscopic examination which has made tissue diagnosis in the operating room a practical procedure. The work of Bloodgood, McCarthy, and Terry in America has done much to popularize this method, but unfortunately in Europe, where the traditions of the older gross pathology are more firmly intrenched, the method, although well-known, is not frequently utilized. Nevertheless, there are indications that newer methods for increasing the accuracy of tissue diagnosis in the operating room will have a direct influence in spreading this technic more widely among surgical clinics.

One of these newer developments in tissue diagnosis is the attempt to devise a differential stain for cancer by the use of some dye which would have a specific affinity for malignant tissue. This line of investigation is closely allied to the quest for a similar vital dye to stain living cells, which



Lipschütz, Z. Krebsforschung, 29 Bd.

FIGURE 11.—TUMOR CELLS, SPECIALLY STAINED BY THE LIPSCHÜTZ METHOD TO SHOW THE PLASTIN REACTION

The center cell in the bottom line shows a white circle with a dark center which is the cell nucleus enclosing the nucleolus. Beside this nucleus is the larger circle of dark staining granules which is the plastin reaction. The rest of the cell area is cytoplasm. The other cells show various other stages of the plastin reaction.

could be utilized as a curative agent by injection into the blood stream or directly into the tumor.

Burroughs working under Leitch at the Cancer Hospital Research Laboratories in London in his experiments on the staining of living cancer cells, has called attention to Isamin blue and Congo red as differential staining agents, but these dyes are not well fixed by the living tumor cells, and their staining reactions with cancer have not been proved specific. Ludford working with Murray in London on similar vital staining has not found trypan blue to be a suitable dye in this regard.

The most outstanding results in this field have been reported by Lipschütz in Vienna (see Figure 10). Using the wet Giemsa's stain in a study of the cell structure of dead cancer tissue preserved in histologic fixatives this worker has called attention to a granular body near the cell nucleus[10] which he believes is specific for the malignant cell. This granular body which Lipschütz has termed the "plastin reaction" is demonstrable only in the most carefully prepared tissues, and varies in its morphology and staining reactions. It may appear next the nucleus, or a slight distance from it, as a perinuclear hood, and its staining reaction may be a strong basic blue, or a neutral white (achromatic) with the Giemsa's stain. Lipschütz has demonstrated this "plastin reaction" in rat and mouse sarcoma, in Rous chicken sarcoma and several forms of human malignancy (see Figure 11). While believing this reaction specific for cancer he has not yet extended his investigations to a sufficient variety of tissues to confirm this contention.

Dr. Hans Hirschfeld in Blumenthal's clinic is contemplating an attempt to confirm the findings of Lipschütz. Should such a structural finding prove specific for cancer its value would not only be in diagnostic work, but would also lend an impetus to the search for a specific cell physiology in malignancy.

A new method of cancer diagnosis applicable to operative procedures based on biochemical methods is now being tried at the Middlesex Hospital by Dickens and Dodds in the Courtauld Institute of Biochemistry. Using the findings and technic of Warburg, the glycolysis of specimens from the operating room is being measured in physiologic solution,[11] and these measurements compared with the microscopic findings. The results have not yet been published, but Dr. Dodds is hopeful that both the presence of cancer and the degree of the malignancy will be demonstrable by such a technic. The present dispute concerning the specificity of the Warburg

[10] *Cell nucleus*—a spheroid body within a cell comprising the reproductive and vital part.

[11] *Physiologic solution*—a solution of sodium chloride and other salts in sterile distilled water in the proportion in which they are found in the blood.

findings for cancer has a direct bearing on the results obtained by this method of diagnosis.

III. Work on the Treatment of Cancer

The cancer patient who is beyond the help of surgery has still little hope for cure by the newer methods of treatment. The best informed clinicians and pathologists over the world are agreed that a definite cancer cure cannot be pronounced until the patient has remained well over a period of five years after the cure has been affected. They are also agreed that a new mode of cancer therapy which is to surpass the present shortcomings must be effective against operative recurrences and generalized metastases. From the standpoint of these considerations most of the alleged cancer cures now in the process of development, or enjoying some vogue of application, have either been prematurely announced or are still in their experimental stages.

Radium

The outstanding exception to such a criticism is the work done with radium at the Pasteur Institute in Paris by C. Regaud and his co-workers and now being successfully repeated in such Clinics as Fichera's in Milan, Blumenthal's in Berlin, Forsell's in Stockholm, Piney in the London Cancer Hospital and in other places in Europe and America. The work of Regaud affords a standard for all those conscientiously endeavoring to establish a new mode of cancer therapy. Since 1919 practically every case treated in his clinic has been carefully followed to ascertain the results attained, and any cures established have been reported in terms of five- and ten-year periods. In addition in every possible case tissue is removed for microscopic examination to substantiate the diagnosis made, and any questionable records are discarded.

Proceeding by such careful methods, these workers feel that they have reached the limits of the therapeutic application of radium, and that further successes in this direction must await some biochemical discovery for sensitizing tumors now refractory to radium. They have found that as a primary form of therapy radium is successful only for cancer of epidermal[12] origin. In other lesions its use is purely palliative. In cancer of the skin about the face and cancer about the female genitalia, radium has a definite field of usefulness as a primary procedure, and has certain advantages over surgery. Such a use of radium, however, is by no means novel and only refines and confirms a definite mode of therapy which is rapidly becoming standard throughout the world. The newer successes with radium have been in the oral cavity, particularly with the tongue. In Regaud's Clinic the following procedure for cancer of the tongue has been worked out.

[12] *Epidermal*—refers to tissues resembling the skin.

1. Small and questionable cancers are removed by surgery alone.
2. Cancer of the anterior (front) two-thirds of the tongue, if unilateral (on one side only), is treated by radium to the tongue and surgery to the neck glands if indicated.
3. Cancer of the posterior (back) two-thirds of the tongue is treated by radium alone to the tongue and to the glands of the neck.

Cancer of the antrum (sinus in the cheek bone) is treated by a combination of radium and surgery. Regaud and his co-workers have found radium of palliative use only in cancer of the bladder, the rectum, the prostate, and the stomach. They believe that cancer of the breast is best treated by operation and advise deep X-ray therapy where surgery is unsuccessful.

For applying radium to superficial tumors the radium needles or radium tubes are held in a mould of bee's wax and sawdust, which forms a very convenient retainer and also a secondary filter. For the palliative use of radium for carcinoma of the internal organs, the radium bomb[13] in a suitable lead shield is applied.

Although radium therapy has been shown by the careful methods of Regaud to have a limited and definite sphere of usefulness, there is a rejuvenated interest in this mode of treatment throughout Europe which is overflowing the boundaries established at the Pasteur Institute, and leading to a more indiscriminate and widespread application of this precious element in cancer.

Colloidal Lead

Approximately five years ago colloidal lead compounds which could be injected in the veins were looked to as a possible new and more hopeful cancer cure. Aside from surgery, X-rays and radium, this is the only mode of cancer therapy which has enjoyed an extensive clinical trial in the large medical centers in recent years. In most of the European clinics where the method has been tried it has been abandoned, but Bell, its originator, in Liverpool and Todd at Bristol are still earnestly endeavoring to work out this mode of treatment successfully on patients with hopeless cases of malignancy. These workers seem definitely encouraged by the results they are getting and believe that by employing lead selenate they have improved the method. Many of the patients are being treated in the out-patient department with weekly injections of this lead preparation in a manner resembling the treatment of syphilitic patients with salvarsan. It is too early to comment on these modified lead treatments as a thorough trial of the method requires clinical follow-ups extending over a period of years. However, to date, biochemists have been unable to confirm any specific fixation by the cancer cells of the lead compounds used, and a scientific basis for this mode of cancer therapy is therefore still lacking.

[13] *Radium bomb*—a massive dose of radium of about 2 grams.

Vital Dyes—Stains for Living Tissues

An experimental attempt to find a chemo-therapeutic agent for cancer in the form of some vital dye has been tried without success in various laboratories. In 1928 W. Munck in Copenhagen claimed to have produced a retarding influence on transplanted carcinomas in mice by the injection of trypan blue, but R. J. Ludford, working with Murray in the laboratories of the Imperial Cancer Research Fund, could not repeat his results.

Bernhardt and Strauch reported similar results obtained with Isamin blue, and treated 50 human cases of cancer intravenously[14] with this dye, supposedly with some beneficial results. Dr. Fichera in Milan, however, has observed no benefit in patients treated by this dye or with trypan blue in his clinic. Experimental work along these lines is being continued by Burroughs and Ludford in London.

The attempt to utilize vital dyes in the treatment of cancer has revealed the fact that the growing tumor cells are practically impervious to these dyes as long as the cell membrane is intact. Over one hundred forty-five various dyes have been tried by different investigators without any promising results to date.

Immunity to Cancer

Among some of the workers in experimental cancer it is held that cure for cancer to surpass surgery and be effective in the later stages of the disease when dissemination has occurred must confer on the patient some immunity to the cancer cell. Thomas Lumsden at the Lister Institute in London is one of those who entertain such views, and who are endeavoring to find a method for immunization against cancer. From his experiments Lumsden concludes that animals immunized against cancer transplants from another animal have more than an immunity to the transplanted cells and have in addition an anti-malignant factor in their blood. His conclusions are based on the finding that the blood serum of the immunized animal will injure cultures of the tumor cells used for transplant and also malignant cells from other tumors, but will not injure the cell culture of normal tissues from the animal who bore the original tumor used for transplantation. Lumsden is endeavoring to develop a method of actively immunizing laboratory animals against transplanted tumors, and believes that he has succeeded in doing this by gradual doses of formalin into the transplanted tumor. If a rat bearing two such tumors, one on either flank, is treated by such formalin injections into one tumor, both tumors will disappear when the injected tumor has been sufficiently injured. Lumsden is now anxious to extend his experiments to spontaneous tumors in mice, but he is awaiting desirable material at present.

[14] *Intravenously*—a method of injecting medicinal substances directly into the veins.

Influencing Tumor Metabolism

In a newer field of investigation other workers are attempting to effect a cancer cure by influencing the metabolism of the malignant cell. Warburg has conducted a group of experiments on mice with the aim of starving out the tumor cells by interference with their sugar and oxygen supply. In an attempt to interrupt the breathing of the cancer cells the animals were made to breathe an atmosphere containing only five per cent of oxygen over a period of several hours. Apparently because of the overcrowding of cells in them and through injury to the cells of the capillary (small blood vessel) walls, the tumors were less resistant to oxygen want than the normal tissue, and biopsy conducted on the anesthetized animals showed that practically all of the malignant cells were dead or had ceased to function. Attempts to interfere with the sugar supply of the tumors by maintaining the animals in insulin shock,[15] did not appear to influence the survival of the tumors.

These experiments of Warburg are of special interest at present, because quite recently Sokoloff of Prague at the International Congress of Physiologists in Boston reported experiments in which the tumor cells were injured by an opposite metabolic effect, too rapid breathing, induced by the injection of a compound containing an extract of the cortex of adrenal glands; and Doctors Coffey and Humber of San Francisco have reported similar results of lysis in tumor cells by treating cancer patients with an extract of the same glands.

It is impossible to predict at this time what consequence these metabolic experiments will have on the future treatment of cancer in human beings. Conservatism compels us to demand compliance with the following three criteria before passing judgment on the validity of any such alleged cancer cure. First, verification based upon the microscopic examination by a competent pathologist of a piece of tissue, removed from the tumor, must be at hand to prove the malignant nature of the disease treated. Second, the cure must be efficacious, not merely on local cancer, but upon recurrences of the disease and cases with generalized dissemination and metastases. Third, the permanency of the cure must be confirmed by following the result of the treatment over a period of five years.

IV. List of Cancer Interviews

DR. PEDOTTI, *Swiss Surgeon, Pupil of De Quervain*, Stadt Hospital, Lugano.

DR. GAETANO FICHERA, *Surgeon and Pathologist, Editor of Tumori, Director General of Istituto Nazionale*, Vittoria Emanuele III, Per lo Studio el a Cura Del Cancre, Milano, Italia.

DR. PEDRO RONDONI, *Biologist, Prof. of Experimental Biology*, Istituto Nazionale Vittorio Emanuele III, Milano, Italia.

[15] *Insulin shock*—a state in which the sugar supply of the blood is depleted by overdoses of insulin.

DR. CARMINATI, *Research Worker* (under DR. PEDRO RONDONI), Istituto Nazionale Vittorio Emanuele III, Milano, Italia.

DR. HASLINGER, *Laryngologist*, Clinic of Dr. Hajek, Allgemeine Krankenhaus, Alserstrasse, Wein, Austria.

DR. GROSSMAN, *Laryngologist and Pathologist*, Clinic of Dr. Hajek, Allgemeine Krankenhaus, Alserstrasse, Wein, Austria.

DR. KARL STERNBERG, *Pathologist*, Wiedener Krankenhaus, Favoriten Strasse, Wein, Austria.

DR. B. LIPSCHÜTZ, *Cytologist*, Franz Joseph Spital, Kundratstrasse, Wein, Austria.

DR. JACOB ERDHEIM, *General Pathologist*, Krankenhaus, Wein, Austria.

DR. FERDINAND BLUMENTHAL, *Internist, Editor of Krebsforschung*, Universitäts Instituts für Krebsforschung, Luisenplatz No. 6, Berlin, Germany.

DR. HANS AULER, *Serologist*, Universitäts Instituts für Krebsforschung, Luisenplatz No. 6, Berlin, Germany.

DR. HANS HIRSCHFELD, *Pathologist*, Universitäts Instituts für Krebsforschung, Luisenplatz No. 6, Berlin, Germany.

DR. (MISS) KLEE-RAWIDOWICZ, *Cell Culture*, Universitäts Instituts für Krebsforschung, Luisenplatz No. 6, Berlin, Germany.

DR. MAX BORST, *Pathologist*, Pathologisches Institut Der Universität München, Nussbaumstrasse No. 26, München, Germany.

DR. ERNEST L. KENNAWAY, *Chemical Biologist*, Cancer Hospital Research Institute, Fulham Road, London, England.

MR. HAROLD BURROUGHS, *Experimentor on Vital Dyes*, Cancer Hospital Research Institute, Fulham Road, London, England.

DR. A. PINEY, *Radiologist*, Cancer Hospital Research Institute, Fulham Road, London, England.

DR. H. J. B. FRY, *Pathologist*, Cancer Hospital Research Institute, Fulham Road, London, England.

DR. (PROF.) DODDS, *Biochemist*, Courtauld Institute for Biochemistry, Middlesex Hospital, Cleveland St., London, England.

MR. DICKENS, *Experimentor with Warburg Apparatus*, Courtauld Institute for Biochemistry, Middlesex Hospital, Cleveland St., London, England.

DR. JAMES A. MURRAY, *Research Director*, Director of Imperial Cancer Research Fund, No. 8 Queens Square, London, England.

DR. R. J. LUDFORD, *Experimentor with Vital Dyes*, Imperial Cancer Research Fund, No. 8 Queens Square, London, England.

MR. GEORGE MAXWELL RICHARDSON, *Biochemistry, Special Student* (working with Dr. Keith Cannon), University College, Gower Street, London, England.

DR. BALFOUR, *Not working on Cancer, Director*, London School of Hygiene and Tropical Medicine, Gower Street, London, England.

MR. THOMAS LUMSDEN, *Immunologist in Cancer*, Lister Institute, London, England.

MR. WALTER SPENCER, *Consulting Surgeon*, Westminister Hospital, No. 43 Harley House, London, England.

DR. ROBERT BIERICH, *Biochemist and Cancer Research*, Krebsforschung Institut, Eppendorf Krankenhaus, Hamburg, Germany.

DR. OTTO WARBURG, *Biochemist*, Kaiser Wilhelm Institute für Biologie, Berlin, Germany.

DR. C. REGAUD, *Radiologist*, Pasteur Inst. for Radium, 26 Rue d'Ulm, Paris, France.

DR. LACASSAGNE, *Radiologist*, Pasteur Inst. for Radium, 26 Rue d'Ulm, Paris, France.

DR. J. W. NANKIRELL, *Radiologist*, Middlesex Hospital, Cleveland Street, London, England.

PRINTING PROCESSES. I. DEPRESSED SURFACE PRINTING

SAUL B. ARENSON, UNIVERSITY OF CINCINNATI, CINCINNATI, OHIO

Introduction

This will introduce a brief series of articles on the various methods of reproducing illustrations and printed matter. In no case will the artistic merits of any particular piece of art be discussed as such. If etchings, for example, are to be considered, it will not be from the point of view of the contributions of etchings and etchers to the happiness of the owner or viewer, but from the standpoint of the chemical and mechanical manipulations involved in the process of making and printing etchings.

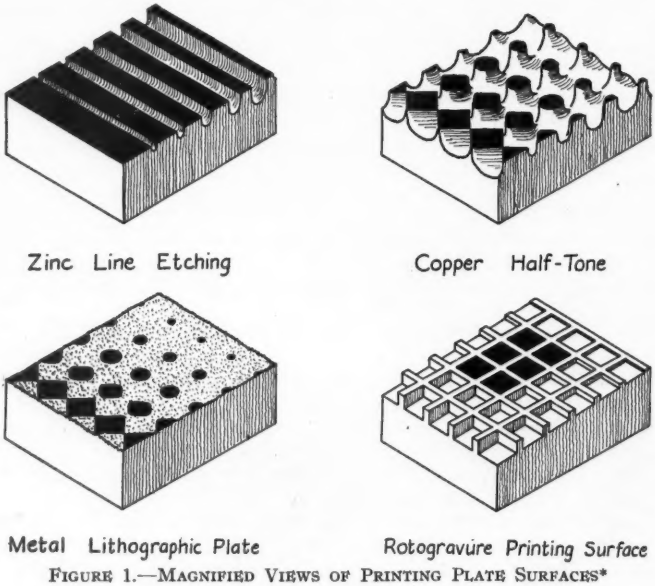


FIGURE 1.—MAGNIFIED VIEWS OF PRINTING PLATE SURFACES*

We have several ways of approaching the general subject of printed reproductions. The order of topics might be chronological, alphabetical, or based on a scheme depending on the type of printing surface. The last-named plan will be used here. The printing surface may be (1) an engraved or "intaglio" one, a depressed surface into which ink flows and from which that ink is transferred onto paper or cloth. Etchings, dry-points, steel engravings, and rotogravure prints are good examples. There is (2) planography, printing from a practically plane surface, where the metal or stone is so sensitized that it will take ink only on certain areas, as in

* These four cuts by courtesy of Mr. Paul W. Dorst, Research Assistant, Lithographic Technical Foundation, University of Cincinnati.

both stone and so-called metal lithography. Lastly, there is (3) printing from an elevated surface, "relief" printing as it is called, on which a relatively stiff ink adheres to elevations and which is transferred to paper. This third process consists in printing from zinc cuts, copper halftones, type, wood cuts, electrotypes, stereotypes, etc.[1]

Etchings

The word etching is derived from the Dutch word "etzen" (to eat). Originally iron plates were used, but now, copper, aluminum, and zinc are quite common. These plates, usually 18 gage (1.2 mm. thick), are cleaned by rubbing with an abrasive, like snake-stone, and finally more carefully polished by some softer material, ordinarily charcoal. They are then covered with a "ground"—an acid-resisting material which protects the plate from the etching solution. Naturally this ground must adhere very tightly to the plate, must not flow, chip, or react with the etching solution. It is usually made by melting together wax, asphalt, and pitch. It may be applied cold, which means that the ground is dissolved in some solvent (an organic liquid such as chloroform) then poured on the metal and the solvent permitted to evaporate, or it may be applied "hot" as a semi-solid, warm paste and dabbed on uniformly.

Next a film of carbon black is carefully deposited on the ground, usually by means of a smoky flame. This is merely to permit the etcher to see better the results of his work. The back of the plate is also covered by some inexpensive resist such as shellac or pitch.

The plate is now ready for the artist. He takes a sharp needle and scratches through the ground down to, but not into, the metal underneath, making the desired design. He may employ a mirror when viewing the plate, for his design must be a mirror image of what is wanted. When completed, the plate is placed in an etching solution, called technically a "mordant."

Quoting Lumsden,[2] some of the mordants used were:

For Iron

15th Century Formula	NH_4Cl	
	Alum	
	$FeSO_4$	
17th Century Formula	White wine vinegar	3 parts
	NH_4Cl	4 oz.
	Vert de Griz	4 oz.
	Bay salt (sel common)	6 oz.

[1] *Part I* of this series will deal with the "intaglio" surface, *Part II* with planography, and *Part III* with "relief" printing.

[2] See references at end of article, page 1036.

	H_2SO_4 KNO_3 Alum	
Dutch Mordant	H_2O HCl $KClO_3$	880 g. 100 g. 20 g.
Common Copper Mordants	HNO_3 solution or $HCl + KClO_3$ or $FeCl_3$	
Common Zinc Mordants	Dil. HNO_3 or $HCl + KNO_3$	

These various solutions will attack the bare metal exposed by the removal of the ground with the etcher's needle. The nitric acid, hydrochloric acid, or sulfuric acid, due to the liberation of a gas by interaction with the metal, will make a relatively wide line, caused by undermining the ground, the gas of course blowing off particles of the protective ground. The Dutch mordant, acting with practically no effervescence, will give a sharp, fine line. After sufficient reaction has taken place, *i. e.*, after the operator believes that the lines are deep and wide enough to hold the desired quantity of ink, the plate is removed from the etching solution, washed, and the excess ground removed by a solvent. If the plate is not to be uniformly etched, the etcher may, after partial etching and before removal of the ground, "stop out" certain areas with varnish and permit the remainder of the plate to be etched more deeply.

In any case, the plate free from ground now has certain depressions where the metal has been removed by chemical reaction with the etching solution, according to the following equations:

$$2FeCl_3 + Cu \longrightarrow CuCl_2 + 2FeCl_2$$

or

$$8HNO_3 + 3Zn \longrightarrow 3Zn(NO_3)_2 + 2NO + 4H_2O$$

The plate is then inked by means of a roller, or by dabbing, and the excess ink is removed with a soft cloth. The unetched portion of the plate is not wiped absolutely free from ink, but a very thin film is purposely left on it to break the contrast between the ink and the paper on which it is to be printed.

Next a dampened sheet of suitable paper is placed on the inked surface, then several blotters and blankets and all run through a press, similar in principle to a clothes wringer, the ink being transferred from the crevices in the plate to the paper. In case of very delicate etchings, only a dozen or so impressions can be made from a single plate. However, several hundred are not uncommon, especially if the zinc etching plate is given a flash coat of copper electrolytically and then surfaced with "steel" in the same way. A very thin film of plated chromium also increases the life of the plate enormously.

Dry-Point (Kalte Nadel)

As the name infers, no etching solution is needed, for a steel needle or diamond-pointed instrument is used actually to cut into the metal plate in making the design. Naturally the greater the pressure applied, the deeper will be the depression in the metal, and the darker will be the inked line formed, for the scratched surface is inked and printed as described for etchings.

On inspection with a hand lens, it is noticed that the cross-section of the ink-holding depression is U-shaped in the case of an etched plate, but V-shaped in the dry-point plate. Furthermore, there will be microscopic burs of curled metal on the surface of the dry-point line, due to the "gouging out" effect of the harsh mechanical cutting instrument, which leaves somewhat ragged edges on the lines of the finished print. Since these burs define the line, and since they are naturally worn away during the printing process, fewer good prints can be made from a dry-point plate.

One of the important uses of the dry-point procedure, however, is to correct an improperly etched plate. Once a plate is etched, additional lines can be added by dry-point, thus combining the results of these two processes on a single plate and print.

Soft Ground (Vernis Mou)

Here we also use a plane, polished plate, covered this time, however, with a relatively soft ground, usually tallow. On top of this ground is placed a thin sheet of paper. Upon tracing a design, again of course as a mirror image of what is wanted, by means of a hard-pointed pencil, sufficient pressure is exerted to cause the ground directly underneath to adhere to the paper. When this paper is stripped from the plate, there remains the bare metal where the design was traced. The plate is then etched in the conventional manner and prints are taken from it as described above. Naturally the lines are a trifle wider, and some of the detail is lost by this procedure.

Aquatint

This is another etching process, but areas are etched rather than lines. The polished prepared plate is "spotted" with rosin by one of two methods. The rosin is dissolved in some volatile solvent and flowed on, or the rosin is dusted on by blowing the powdered material into a box in which a plate is placed horizontally. The deposit is made to adhere to the plate by warming, where each little particle melts and individually adheres to the plate. This ground differs from the tallow or wax grounds mentioned earlier, in that it is not a continuous one. In other words, a quantity of rosin insufficient to completely cover the whole area, has been used. That means that under a hand lens, small dots of the bare metal and of rosin can be seen over the entire surface of the plate.

Suppose the aquatint is to represent a block, capital **E**, with its shadow, the **E** to be in black and the shadow in grey, on a white paper. The **E** and its shadow are traced on the ground, and the rest of the plate is "stopped out" with acid-resistant ground. The plate is then dipped in the mordant. After an exposure of sufficient length of time to etch the **E** and its shadow, the plate is removed, washed, and now the shadow is "stopped out," as well as the background. Now when the plate is again etched, the block **E** will be the only area reacted upon by the etching solution. When this plate is removed from the solution, washed and cleaned, it forms a printing surface holding two different thicknesses of ink, none for the background, more for the shadow, and the greatest depth for the **E** itself. The printed replica shows tones in place of lines, etched-areas in place of etched lines. The process can become as complicated as the artist chooses.

It must be remembered that since the surface had all over it small areas of mordant-resisting rosin, the surface of the etched plate is made of millions of little wells, the walls being the unetched plate.

Bank Note and Steel Engraving

This is essentially line and dot engraving, done from an especially treated iron plate. In the case of the lines, they are chiseled out by moving a small chisel forward. The shavings are blown away, and the burs adhering on the edge of the chiseled line are removed by a scraper. Generally the steel plate when finished is given a flash coat of copper electrolytically, and then chromium plated in the same way. Previous to the chromium-plating improvement, making tens of thousands of prints would decrease the depth of the engraved lines to the extent that the plate became worthless. However, surfacing the printing plate with a hard metal like chromium has increased the life of the individual plate manifold.

In making steel bank-note engraving plates, usually a master plate is made and case hardened. Then a relief duplicate is made by impressing the original plate against a relatively soft steel plate, which in turn is also case hardened. From this second plate, many duplicates of the original can be made by similar impression on soft steel.

Photogravure (Rotogravure)

The light and shade in an etching process depend ordinarily on the depth of the etched surface, for the deeper it is, the more ink is retained to be transferred to the paper. The etched depression must be slightly rough to retain the ink. In the photogravure process, the etched surface consists of millions of little wells, each capable of holding a different depth of ink. On printing from such a surface, the result looks like a continuous-

tone photograph, rather than a newspaper halftone, for these wells are so close together that they can only be seen with a hand lens.

The process is roughly as follows: carbon tissue, which is a paper having a surface coating of gelatin and a reddish brown pigment, is sensitized by the addition of potassium dichromate ($K_2Cr_2O_7$), to which ammonium hydroxide (NH_4OH) has been added until the color changes from the orange of the dichromate to the yellow of the chromate. This tissue is exposed to light directly underneath a screen made of black squares and

FIGURE 2.—ROTOGRAVURE SCREEN, GREATLY MAGNIFIED

clear lines, as illustrated in the sketch below. These clear lines are placed uniformly 150 to 175 per linear inch. Light going through the clear spaces, after long exposure, hardens the bichromate-gelatin directly underneath, forming relatively insoluble gelatin. The areas directly underneath the black squares are, of course, unaffected.

The screen is now removed, and a continuous-tone positive substituted and the carbon tissue is again exposed to light, this time, however, for a relatively short time. The same thing happens, for where the light falls on the tissue, it hardens the gelatin. This continuous-tone positive is

made by merely photographing the subject and, after development in the conventional manner, making a positive plate of this negative in the same way that one would make a positive print of any negative. The tissue now shows varying depths of insoluble gelatin depending on the opacity of the continuous-tone positive, plus a regular pattern of criss-crossed parallel lines of very highly tanned gelatin.

This tissue is now ready to be placed on the specially prepared copper cylinder. This cylinder is usually made of a cast iron core on which copper has been plated electrolytically from a copper sulfate bath until about a 4 mm. thickness has been built up. Naturally the cylinder has been smoothed and cleaned in preparation for the exposed carbon tissue, which is to be firmly attached Sometimes the cleaned grained copper is given a thin coating of gelatin to act as an adhesive, while ordinarily the copper is merely cleaned by a dilute aqueous solution of salt and acetic acid.

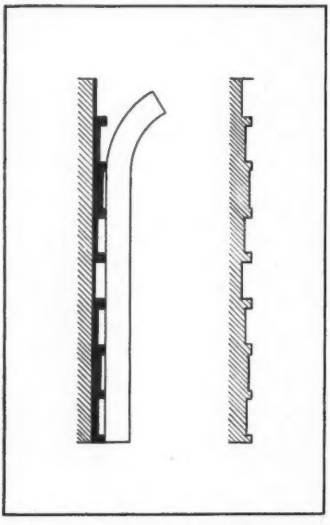


FIGURE 3.—*Left:* STRIPPING THE PAPER FROM THE COPPER CYLINDER LEAVING THE TANNED GELATIN (IN BLACK) ON THE COPPER. *Right:* SAME SECTION OF CYLINDER AFTER ETCHING. NOTICE THE WELLS OF DIFFERENT DEPTHS

The exposed paper, face downward on the copper cylinder, is permitted to soak in warm water (30–40°C.) until the sensitive exposed film adheres to the copper and the paper can be removed with safety. There are now on the copper varying thicknesses of tanned gelatin, from 0.01 mm. in the high-lights on the original positive down to the thinnest film on the bare metal, in case of the most opaque portions of the screen and positive. See Figure 3.

Areas not to be etched are now stopped out with bitumen or asphalt paint. The cylinder is then revolved in ferric chloride solutions of varying concentrations, starting with the most concentrated solution. This ferric chloride must penetrate the film of hardened gelatin before it can react with the copper underneath. Obviously it reaches the copper first through the thinnest films and etches deepest there. Therefore the surface is pitted by millions of holes of varying depths. These are the future ink-containing wells (see Rotogravure Printing Surface, Figure 1, page 1028). Notice that the cross-section of the well is large compared with the thickness of the intervening wall.

The etching reaction at first may be:

$$FeCl_3 + Cu = FeCl_2 + CuCl$$

especially if the etching solution contains too little free hydrochloric acid. This reaction is not desired on account of the insolubility of the cuprous chloride. Too large a hydrogen-ion concentration is also inadvisable, due to its increasing the rate of penetration and etching too rapidly. The acidity is usually controlled by adding peptized ferric hydroxide.

Naturally the temperature of the etching bath plays an important part in the rate of etching. A thirty-five per cent ferric chloride solution will etch to a depth of 1 mm. in ten hours at 15°C., while either at a lower or higher temperature that figure is decreased. It will be noticed that not only must an accurate control of the hydrogen-ion concentration be made, but also of the temperature.

After the etching is completed, taking into consideration the type of paper on which the material is to be printed, the size of the edition, etc., the cylinder is washed with water, then 5% sodium hydroxide, followed by water and a 5% hydrochloric acid solution, then rapidly dried. The cylinder is now ready for the press where it comes in contact with a fluid ink, then with a flexible steel "doctor blade" which removes the superfluous ink from the surface, then with the paper on which the ink is to be transferred. Due to the fact that the printing is from a cylindrical surface, the process is a continuous one.

Since we are not using a stiff ink, but a rather fluid one, the ink flows together, more or less, when transferred to the paper, especially if the quantity of ink is large. That accounts for the fact that, even under a hand lens, it is difficult to recognize individual dots of ink in the darker portions of the print, while they are readily noticed in the high-lights. But rather than being a handicap, this flowing together actually is an advan tage, for it removes the harshness and makes the finished product more like a continuous-tone photograph.

An average run is about 175,000 impressions, after which the surface is reground, polished, and re-etched. Depending on the thickness of copper originally deposited, the cylinder is good for at least twenty-five runs before additional copper need be plated on the core.

In the case of colored rotogravure, a rather expensive process, but one giving very beautiful results, separate cylinders are made for each color desired, and the paper is printed successively with each color in perfect register. Since the theory of colored photogravure is similar to that employed in making colored lithographs and colored prints, it will be discussed in greater detail in future articles. Newer improvements in this field consist in chromium plating the finished cylinder to minimize the risk of scratching in handling, and in using thin copper plates in place of the heavy cylinder.

A very fine article covering the various theoretical phases of photogravure etching has been written by H. Mills Cartwright, published in "Proceedings of the Seventh International Congress of Photography," July, 1928, under the title "The Progress of Photogravure Etching."

Inks

The drying of an ink takes place by oxidation, evaporation, and penetration into the paper. The paper used in a photogravure process will not permit of any great penetration because of its glazed surface, consequently most of the drying is accomplished by evaporation. To aid in this process alcohol is sometimes added and the printed paper warmed by a heated drying drum. The binder used to keep the pigment or lake on the paper is usually a natural hydrocarbon called Gilsonite. However, it is colored too dark to be used in the lighter colored inks, and so resins and gums are substituted. Obviously gritty particles must be absent for if they got in between the plate and the "doctor blade" they might scratch the printing surface.

The ink used in most intaglio processes, except rotogravure, must have an oil, which on oxidation can bind the pigment to the paper. This is usually linseed oil, which has been previously treated with catalysts to aid in the oxidation.

The ink must dry fast so that it will not offset on to the next sheet. The coloring matter may be a lake, an earthy pigment, an artificially prepared insoluble colored substance, or some form of carbon black.

Additional References

There is a wealth of very valuable material in these books:

HERMANN STRUCK, "Die Kunst des Radierens," Paul Cassirer, Berlin, **1908.**

ERNEST S. LUMSDEN, "The Art of Etching," J. P. Lippincott, Phila., **1925.**

CHARLES W. HACKELMAN, "Commercial Engraving and Printing," Commercial Engraving Publishing Company, Indianapolis, Indiana, second printing, revised, **1924.**

Chemical Abstracts Now Covers 1500 Periodicals. According to E. J. Crane, in a recent issue of the *News Edition* of *Industrial and Engineering Chemistry*, there are over 1500 periodicals now appearing which publish at least occasional articles reporting new information of chemical interest. In its efforts to cover the chemical literature of the world completely, *Chemical Abstracts* is continually seeking to learn of new scientific journals and to unearth obscure ones. The total number systematically examined has just reached the 1500 mark, and experience has shown that there is always another to be found in Japan or Russia or some other distant country and that one or two new ones will put in their appearance before this can be printed.

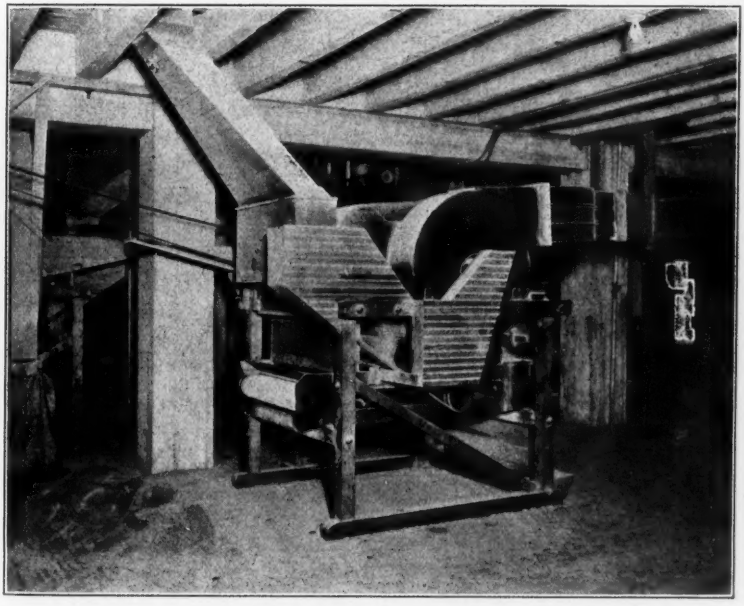
These periodicals have been classified: (1) by subjects or fields covered, and (2) by countries in which they are published. Tables showing the number and percentage in each class accompany the original article.

THE PEANUT INDUSTRY. II. PREPARATION OF PEANUTS FOR THE MARKET*

D. F. J. Lynch, Washington, D. C.

The Cleaning Process

When the people of this country first became acquainted with the peanut after the Civil War the cleaning and preparation of the nuts for the market were all done by hand labor. Although the many cost-reducing

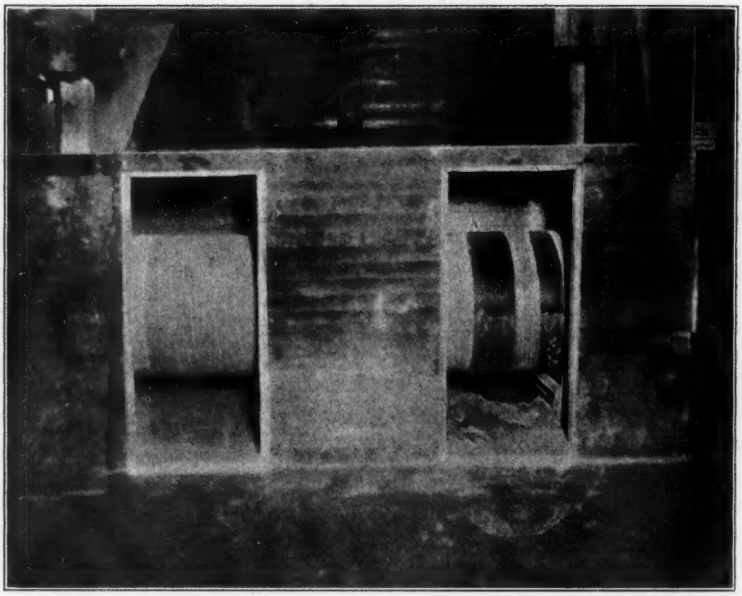


A Suction Fan in a Cleaning Plant

One of the many fans scattered throughout the factory to draw out light-weight pods, trash, and dust.

improvements in the methods of planting, cultivating, and harvesting the peanuts have been a great help to the industry it is doubtful whether this business would have reached any size or real importance without the invention of machinery for cleaning and shelling the peanuts on a large scale and the establishment of modern cleaning and shelling fac-

* Acknowledgment is here made to W. R. Beattie, Horticulturist, Bureau of Plant Industry, for the use of cuts from *U. S. Dept. of Agriculture Farmers Bulletin* No. **1127**; to Harold J. Clay and Paul M. Williams, Marketing Specialists, Bureau of Agricultural Economics, for use of cuts from *U. S. Dept. of Agriculture Bulletin* No. **1401**; and to Harold J. Clay for criticism of the manuscript.



"TUMBLER" IN WHICH PEANUTS RECEIVE A COATING OF FINE WHITE POWDER BEFORE BEING GRADED AND SACKED

Peanuts enter revolving cylinder at left-hand portion of picture and leave at right-hand end. Surplus powder has fallen through wire mesh to floor in right-hand portion of picture.

tories.[14] The first practical cleaning plant was built in 1876 in Norfolk, the second in 1880 in Smithfield, Virginia, and by 1885 this business was well started.

The farmers' stock reaches the plant with some dirt in the bags, together with such other foreign material as stems and small stones. For the continuous operation of the factory there must be stored in the plant or very close at hand a good supply of peanuts. The bags of farmers' stock are emptied into the storage bins, the nuts being separated according to the distinct varieties, and also each variety is sorted according to grade. A mechanical elevator carries the pods to the top of the plant where it dumps them into large hoppers, from which the peanuts are fed to the cleaning machinery. The pods are usually fed first to a sand or dirt reel in which the hulls are cleaned by rubbing against one another and some of the stems adhering to the pods are removed. The reel has small holes through which the dirt drops out.

[14] *U. S. Dept. Agr. Office Sec. Circular* **81.**

WORKING AT PICKING TABLES IN PEANUT FACTORY IN VIRGINIA
Suction pipes are at end of long belts to draw out chaff and dust.

The next step is the removal of the stems. This is accomplished in a "stemmer." One type of stemmer is in the form of a cylinder made with iron pulleys so attached to a shaft as to allow a small space between each pulley. Under the cylinder are rows of small saws which extend up into the spaces between the pulleys, catching the stems, pulling or sawing them off. At this point, as well as at many other points throughout the plant, a blast of air from the fans is introduced for an air separation of the light foreign material from the pods. The sound pods are then regraded. The operation at this point is done by machinery. The pods are dumped into a sloping cylinder which is made of iron bars looking like a large parrot cage without top or bottom. The space between the bars varies along the length of the cylinder, allowing the smaller size nuts to drop out first, and the largest jumbo grade nuts come out at the end of the cylinder.[5]

The color of these cleaned pods depends upon the color of the soil in which they mature and the amount of weathering of the pods in the stocks. To give all the pods in the batch the same color and in this way to improve the appearance of the nuts for sale purposes, the pods are next dusted

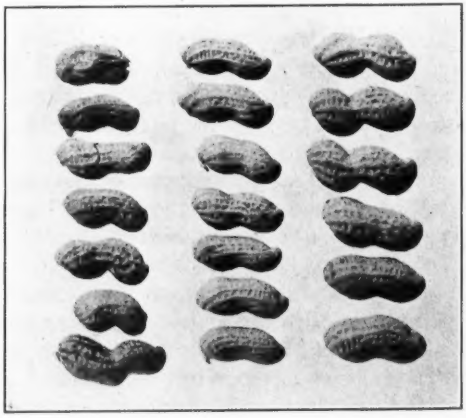
[5] *U. S. Dept. Agr. Bull.* **1401.**

SEWING A FILLED SACK OF PEANUTS IN THE SHELL—LAST STEP BEFORE THE PEANUTS ARE READY TO SHIP

The peanuts come through the bagging spout from a picking table shown in the preceding illustration.

with a white powder in polishing drums. Now the pods are ready for the "picking tables" which consist of an endless belt traveling over a long table. The goods are dumped on the belt and the belt carries the pods slowly between two lines of pickers seated on each side of the table. These pickers remove by hand the defective pods from the slow stream of peanuts. Leaving the "picking tables" at the end of the table the nuts drop in receptacles, are bagged, and are then known in the trade as "cleaned" or unshelled goods.

It is from the better grades of the farmers' stock that the unshelled Virginia goods come. All the peanuts of the Spanish and Runner types are shelled. In the sale of the unshelled goods much depends on the size. The smaller Spanish pod would, therefore, fare badly in competition with the large-podded Virginia varieties. The unshelled Virginias are offered to the trade in three grades: jumbos, the largest or first grade; fancies, the second grade; and extras,



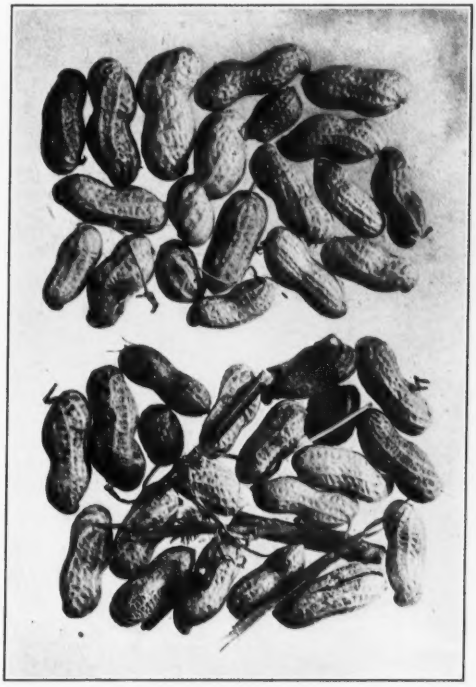
GRADES OF VIRGINIA TYPE PEANUTS IN THE SHELL

Peanuts in right-hand column are jumbos; those in the center, fancies; while those in the left-hand column are extras. (*Reduced two-thirds.*)

or the poorest grade. Each grade is definitely standardized by the trade, limiting the number of pods to the pound in each grade.

Shelling

From the lower grades of farmers' goods we obtain our shelled Virginia peanuts. Sometimes, however, as in 1922, the demand for shelled Virginias is such that farmers' stock is shelled straight, that is, all grading in the pod is omitted. Of course, as stated above, all of the Spanish and Runner peanut crop that is gathered goes to the sheller.



FARMERS' STOCK VIRGINIA-TYPE PEANUTS
Well picked (*upper*) and poorly picked (*lower*).
(*Reduced two-thirds.*)

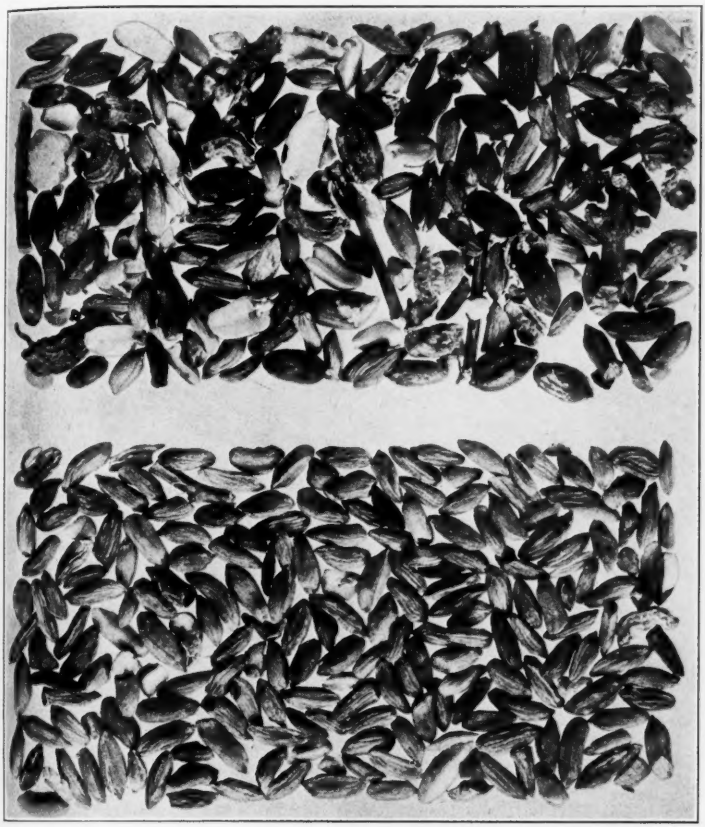
The shelling process is less complicated than the cleaning process and therefore less machinery is needed. The goods are run through a stoner which consists of an upward current of air and the small stems and any material of higher specific gravity than the pods fall out, while the pods are carried on. Next the goods are run through a dirt reel, in which process the adhering dirt is rubbed off and then a blast of air from a fan blows off the light trash. Now the pods are ready for the sheller, which consists of two cylinders. One cylinder is stationary, while the other rotates, bringing around steel "beaters" which strike and crack the hulls. The mixed meats and broken hulls fall through a current of air which removes the lighter hulls from the meats. The meats are now run over screens which grade the meats. The small, shriveled meats fall through the smaller holes at one end, while the extra large meats are carried through to the end of the screens. As in the case of the unshelled nuts the final operation is the hand picking by operators seated at the "picking tables."[5]

Shelled Grades

Shelled Virginias, as in the case of the nuts in the shells, are graded for the trade. First we have the extra large grade which must not number more than 33 to the ounce, and the No. 1 grade, which cannot exceed 42 to the ounce. In these two grades foreign matter and splits are practically excluded. The No. 2 grade contains shrivels in addition to splits but the amount is limited. When the No. 2 grade is destined for food products these meats may be rerun through the "picking tables" for another inspection. As No. 2 grade peanuts have on the split faces considerable dirt which is retained after passing through the shelling machinery, those interested in the peanut butter industry feel that it would be to the advantage of this industry if no No. 2 nuts were used therein but sold with the No. 3 grade to the oil mills for crushing.

FARMERS' STOCK SPANISH PEANUTS
Well picked (*upper*) and poorly picked (*lower*).
(*Reduced two-thirds.*)

To the layman the grading of the Virginias seems standardized and rather definite. Those interested exclusively in the Spanish type of peanuts, speaking of their business, say, however, that up to 1921 our grades were formerly as indefinite as those of the Virginia peanut. In 1921 the Bureau of Agricultural Economics of the Department of Agriculture, after a thorough and detailed investigation, offered tentative grades for shelled white Spanish peanuts to the trade. These grades have been revised as circumstances have suggested and have proved very popular with all those interested in this business. At the request of the Peanut Associations the Federal Food Products Inspection Service, which has facilities for inspections in practically all our



OIL STOCK

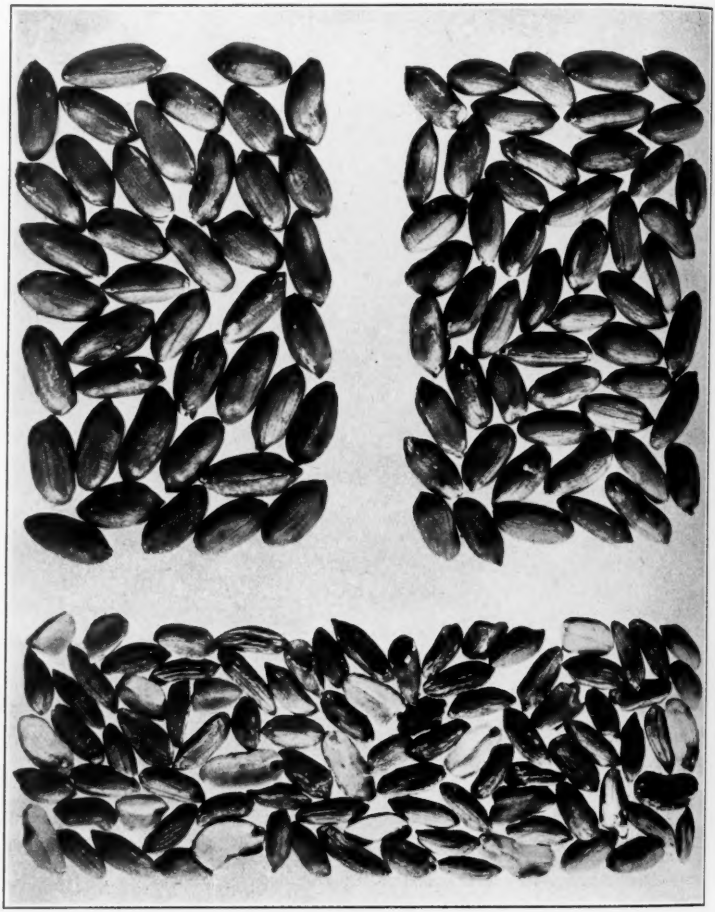
Different lots of oil stock from plants running Virginia-type peanuts. (*Reduced one-third.*)

large cities, has been made available to the peanut industry for shelled Spanish goods.

Roasting

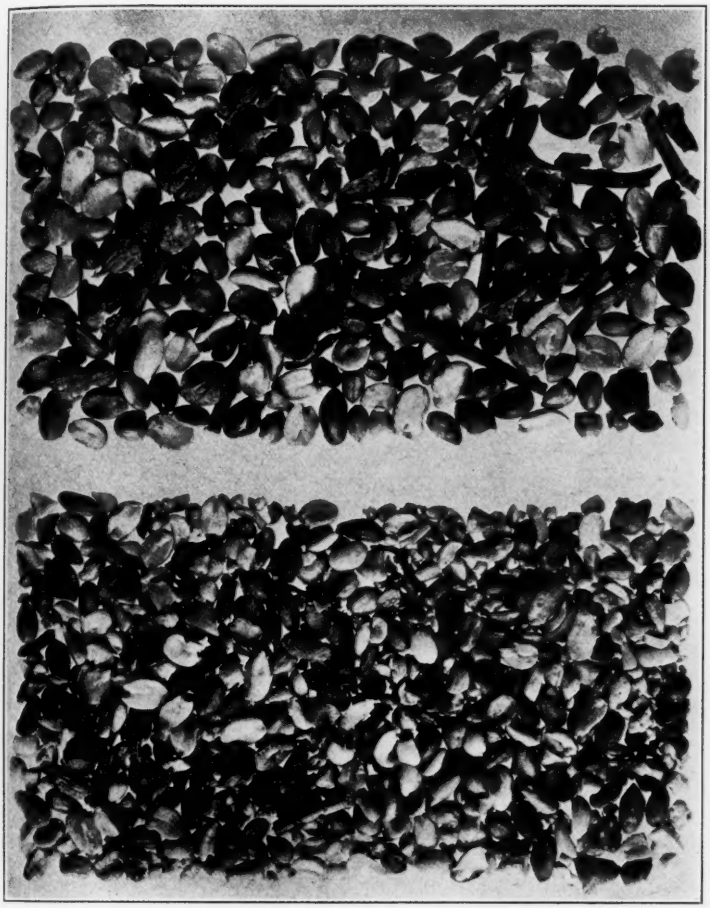
Neither the unshelled peanuts, when they leave the cleaners, nor the shelled nuts when shipped by the shellers, are ready for consumption. Peanuts, like legumes, require cooking to make them edible. They are usually roasted.[15] To the American public, until a comparatively short time ago, the word "peanut" conveyed a picture of a street vendor dispos-

[15] "Nutrition," W. S. Hall, Northwestern Univ. Med. School, pp. 69–70.



THREE GRADES OF SHELLED VIRGINIA PEANUTS
Extra large (*upper left*), No. 1 (*upper right*), and No. 2 (*below*). (*Reduced one-third.*)

ing of his wares of warm roasted nuts in the shell to small boys at ball games, circuses, and recreational resorts. The vendor usually roasted his peanuts over a charcoal burner just as he sold them. Most of us can remember instances where the vendor's roasting amounted to anything from merely warming the nuts to actually burning them. Today, however, practically all the roasting is done by expert roasting establishments and the vendor merely keeps his wares warm. Roasting is carried out in rotating cylinders over some source of heat. The temperature and time of

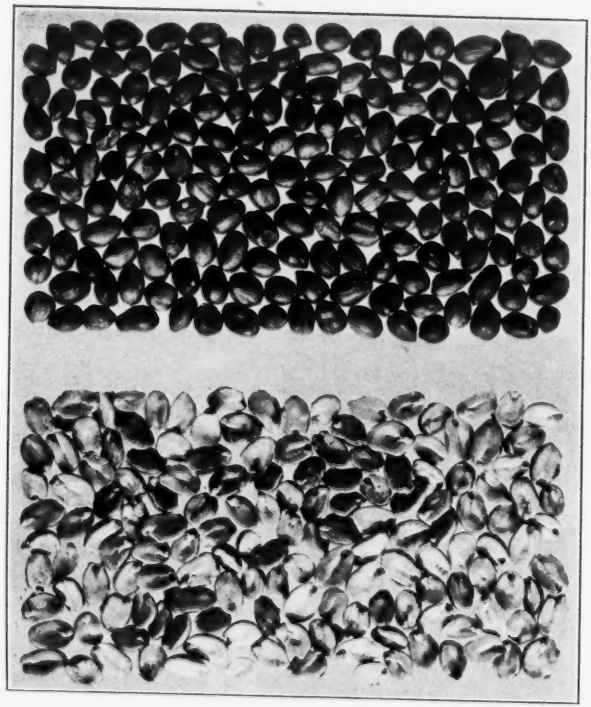


OIL STOCK

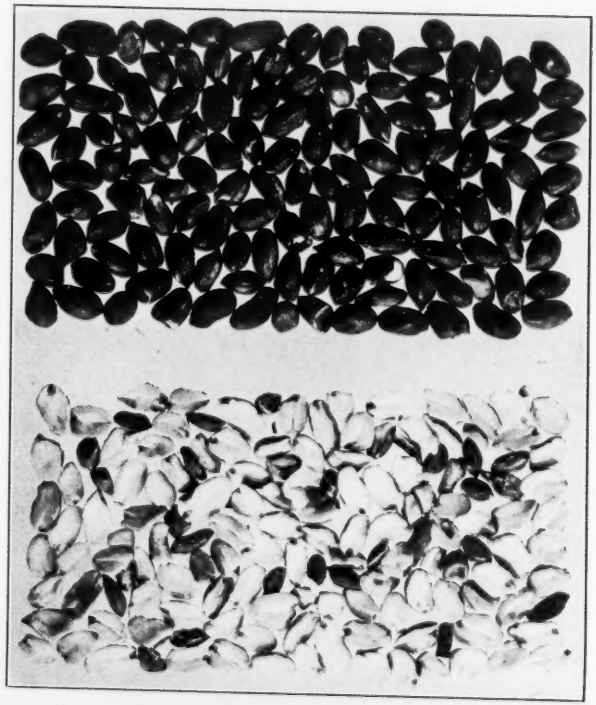
Different lots of oil stock from plants running shelled Spanish peanuts. (*Reduced one-third.*)

roasting vary with the operators, but are dependent upon one another. The speed at which the cylindrical roaster is rotated depends on the size of charge or weight of nuts roasted. As this business of roasting unshelled peanuts has grown, it has tended to gravitate to the coffee roasters in the large cities. This is due, no doubt, to the long experience acquired by these men in a similar business, and, incidentally, this peanut roasting seems to have brought them a very profitable business sideline.[16]

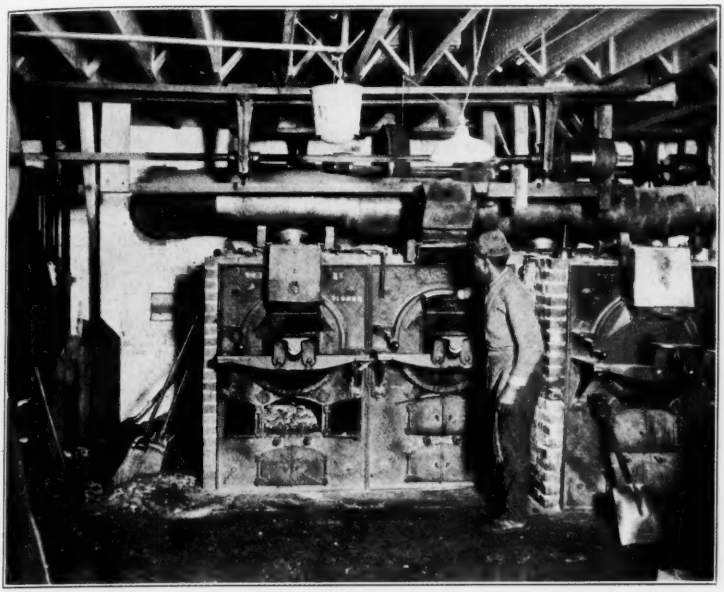
[16] "The Peanut Promoter," vol. VI, no. 6.



SHELLED SPANISH
U. S. No. 1 (*upper*) and U. S. No. 2 (*lower*). (*Reduced one-half.*)



SHELLED RUNNERS
U. S. No. 1 (*upper*) and U. S. No. 2 (*lower*). (*Reduced one-half.*)



Roasting Shelled Virginia-Type Peanuts in a Virginia Factory

The revolving cylinders are heated in this instance by coal fires, but usually gas is employed. The operator is testing the peanuts to see if the roasting has been completed.

There have been lately attempts to prepare roasted salted peanuts in the shell. According to a United States patent issued to Messrs. F. and H. Baker,[17] this can be accomplished by forcing a cold salt water solution through the pores of the shell under pressure and then evaporating the liquid from the shell. It is understood that this product has been marketed to some extent.

Salted Peanuts

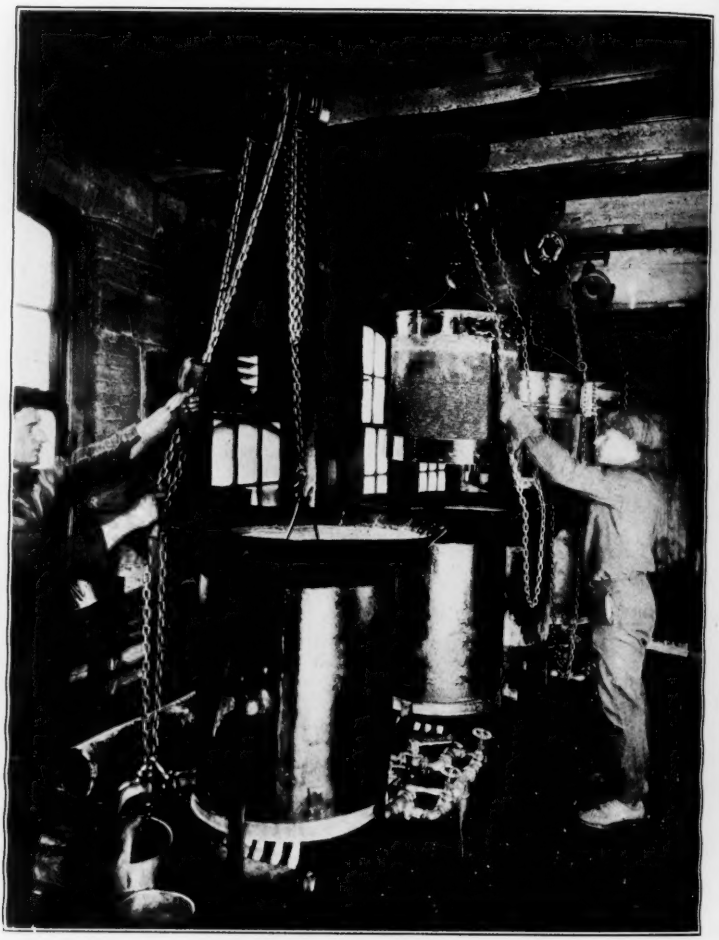
From that status in which roasted peanuts in the shell constituted the peanut industry there have been many changing developments. It is estimated that, including the imported nuts and reducing both shelled and unshelled nuts to a common basis, there are sold, today, four or five times as many shelled as unshelled peanuts. This change was brought about chiefly by the salted peanut industry. The salted peanut industry is not much more than twenty-five years old. The difficulty seemed to be, at first, in the marketing and not in the preparation. The needed impetus to this business was given by the introduction of the salted peanut

[17] U. S. Pat. 966,514.

Shelled Runners
U. S. No. 1 (*upper*) and U. S. No. 2 (*lower*). (*Reduced one-half.*)

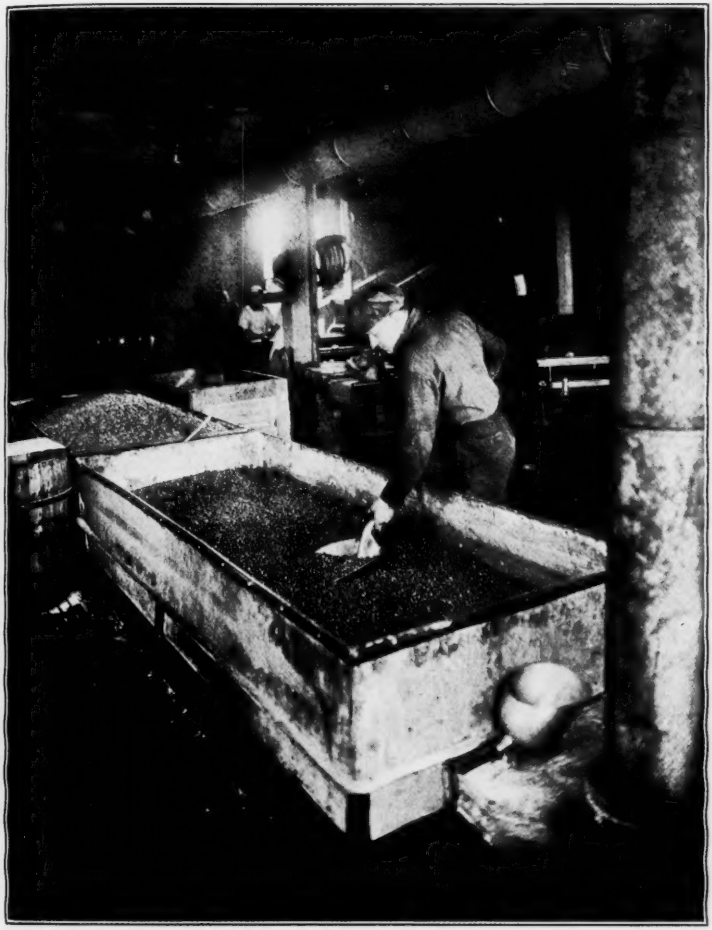
Shelled Spanish
U. S. No. 1 (*upper*) and U. S. No. 2 (*lower*). (*Reduced one-half.*)

XUM



COOKING EXTRA LARGE SHELLED VIRGINIA PEANUTS IN VEGETABLE OIL PREPARATORY TO SALTING

penny vending machine. Because of their irregularity in size and shape the Virginias could not be handled by these vending machines and, as a result, for some time the salted peanut industry handled only the Spanish variety. The small, regular size and shape of the Spanish nut were well adapted to the mechanism of these machines. These Spanish nuts are usually roasted and salted without removing their thin brown skins, and most of us can remember when salted peanuts were only procurable in that form.



MIXING SALT WITH THE PEANUTS PREPARATORY TO PACKING
The vegetable oil in which the peanuts were cooked has been drained off by a suction pipe.

The first operation carried out by the salters is dumping the meats on the "picking tables" again for another inspection and removal of foreign matter. The nuts are then put into a steel colander and the colander containing the meats is lowered into a hot vegetable oil. As in the roasting of the unshelled nuts the time and temperature vary with the plant, but are dependent on each other. Sogginess in the nuts results from not having the temperature sufficiently high when the nuts are lowered into the oil.

When browned to the desired color the colander is raised and the oil drained from the nuts. Usually the salt is sieved on the nuts at this point, although some manufacturers salt the meats before cooking. The consuming public readily accepted the salted peanut almost as soon as it was introduced into the market and returns from the vending machines exceeded expectations. The five and ten cent stores were not slow in recognizing a salable product and enormous quantities were purchased by them in bulk and sold to the people of this country.

Naturally there was no reason why the salted peanut industry should be held exclusively by the Spanish peanut as the marketing of salted peanuts outgrew the penny vending machines. The salters of the Virginias have entered the market by trying to offer a more attractive product. In ten years this industry seems to have made its place in the field. The salters have wisely picked only the largest grade nuts for salting. The roasting is carried out in two steps. In the first step the meats are only roasted enough to loosen the thin red skin. At this point the meats are removed and run through the blancher which consists mainly of two fine brushes revolving in opposite directions inside a box. At first the nuts were split in the blanching but now there are whole nut blanchers. The skins are blown off and removed by suction from the meats, which are dumped onto the "picking table" for inspection and the hand-removal of any skins adhering to the nuts. Then the nuts are cooked in oil similar to the cooking of the Spanish nut. The nuts, upon reaching the desired brown shade, are removed from the cooker and salted. The whole-nut salted grade seems to be in greater demand and brings a higher price, although a large number of the split kernels are consumed yearly by the American public.

Up until a few years ago it was conceded that more peanuts passed into consumption as salted peanuts than in any other way. There had been for some time, of course, a steady and yearly increasing demand for peanuts by the candy makers to incorporate into their peanut brittle and similar candy products. Today, however, the stupendous growth in sales and almost daily increasing demand by the American public for the new five-cent candy bars and the corresponding demand by these candy-bar makers for peanuts, which seem to be used in the majority of these candies, have about convinced the marketing specialists that the salted peanut industry has had to relinquish the first place to the candy makers. As the roasted nut in the shell, as the salted peanut with or without the skin and either whole or split, and as the candied peanut imbedded in confectionery, the American people consume yearly thousands of tons of peanuts. There are also other forms in which the public uses enormous amounts of this important and nutritious food product, but they are more aptly treated under the heading of Peanut Products, which will appear in June.

THE NEW FRENCH INSTITUTE OF PHYSICO-CHEMICAL BIOLOGY[1]

MADAME Y. KHOUVINE,[2] INSTITUTE OF PHYSICO-CHEMICAL BIOLOGY, PARIS, FRANCE

A bequest of 30 million francs for the establishment of an Institute of Physico-Chemical Biology was made about three years ago by Baron Edmond de Rothchild. Since then the form of organization of the Institute has been determined, many members of its staff selected, and the construction of the new laboratories completed.

Baron Edmond de Rothchild became interested in the development of science many years ago and his previous gifts include 10 million francs for research in physics and chemistry. The revenues from this fund are used to aid investigators and for the purchase of apparatus and material needed by them. He is also one of the contributors to the recently established Henri Poincaré Institute.

Baron Rothchild was a personal friend of Claude Bernard and learned from him that the most effective development of biology requires the aid of both physics and chemistry. In a letter to M. Paul Appel, former rector of the University of Paris, Baron Rothchild mentions some of the reasons which led him to found the new institute. He wrote:

> I knew Claude Bernard intimately. He often came to dine at our house with his friend Davesne and frequently brought Pasteur. As you know, Davesne was also a great genius whose superiority was not justly appreciated. To him is due the honor of being among the first to recognize the existence of the organisms responsible for diseases. In the conversations which we had he emphasized the importance of this discovery. Since his time attention has been so intensively directed toward the study of bacteria that most of the great work in general biology has been abandoned; consequently, it has appeared to me that research along this line should be resumed. It is necessary, however, in doing so that the aid of physics and chemistry should be enlisted to the fullest extent since it is now evident to the scientific world that in reality life, after once inaugurated, does not continue except by physico-chemical reactions.

The investigations which will be pursued in the new institute are thus sharply defined. Biology will have at its disposition all the resources which can be supplied by physics and chemistry. These three branches of science will be united in a single organization and thus be employed jointly in the study of problems which they could not solve separately. The new institution will provide facilities for biological research such as have not existed in France up to this time and will, therefore, not duplicate the work of any other French laboratory.

The new Institute is being erected on Rue Pierre Curie in the university, or Latin, quarter of Paris and in the midst of the Institutes of Radium, Applied Chemistry, Physico-Chemistry, and that of Henri Poincaré.

[1] Translation by A. Seidell, Hygienic Laboratory, U. S. Public Health Service, Washington, D. C.

[2] Doctor of Science, Assistant Biological Chemist.

The site was a part of a large property which belonged to the University of Paris. Some 30 years ago it was occupied by a convent surrounded by gardens and wheat fields. It may be expected that the harvest which French youth will here cultivate with so much faith in science, will be as abundant and beautiful as the golden grain which formerly ripened on this hill of Sainte Geneviève near the Sorbonne and Pantheon.

Gaillac-Monrocq & Cie, Paris

INSTITUTE OF PHYSICO-CHEMICAL BIOLOGY, RUE PIERRE CURIE, PARIS

The establishment of this Institute has been made possible through a bequest of Baron Edmond de Rothchild. The site, belonging originally to the University of Paris, was occupied some 30 years ago as a convent.

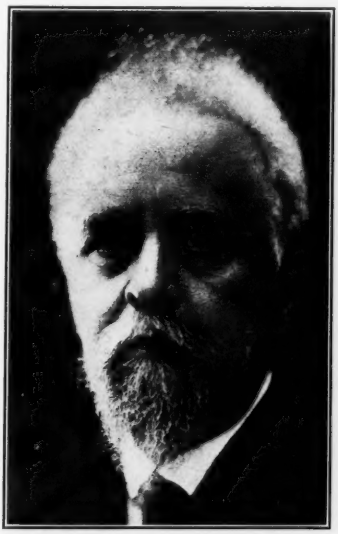
The several E. de Rothchild foundations have been placed under the direction of a council consisting of twenty-four members. Some of these have been designated by scientific organizations and the others selected by the Council itself. M. Paul Appel has been chosen as president. There are two committees of the Council, one for physics and chemistry and the other for biology. Among the members of the latter are Messrs. Jean Perrin, d'Arsonval, and Ch. Richet. The Council has also designated a permanent commission charged with the administration and with the coördination of the work to be pursued in the Institute of Physico-Chemical Biology. This commission is composed of Messrs. Perrin, Urbain, Mayer, and P. Girard, and it is to the last-named of these that the administration of the new Institute has been assigned.

There will be no courses of instruction, since the entire activities of the Institute will be devoted to research. The work will be conducted by trained scientists under the direction of the chiefs of the several divisions. The Institute will have a permanent staff as well as offer its facilities to qualified persons who may desire to pursue special research in physico-chemical biology for longer or shorter periods.

The seven divisions into which the work has been divided are: physics, chemistry, physiology, biological physics, biological chemistry, biological-physical chemistry, and experimental cytology.

The chief of the division of physics is M. Jean Perrin, who is a member of

the Institute of France and a professor in the Sorbonne. It is unnecessary to mention all of the admirable work to which this eminent physicist owes his renown. Attention may be called, however, to the decisive experiments by which he demonstrated that the cathodic rays, which are produced when an electric discharge traverses a rarefied gas, always carry with them negative electricity and are deviated by an electric field. More recently, generalizing from the results of his work on the phenomena of luminescence, he was led to the remarkable theory, according to which there are no chemical reactions without emission or absorption of infra red, visible or ultraviolet radiations. Finally, it will be remembered that in 1926 he was awarded the Nobel Prize for his discoveries in the field of the atomic theory of matter. While studying the law of distribution in a suspension of the grains of gutta gum he succeeded in determining the Avogadro number with a remarkable precision. This number enters into many formulas of physics and the knowledge of its value permits, among other things, the estimation of weights of molecules and of atoms in chemical compounds.



JEAN PERRIN, CHIEF OF DIVISION OF PHYSICS

M. Jean Perrin's son, Francis Perrin, will be in active charge of the division of physics. His researches have been directed particularly to the question of fluorescence from the standpoint of chemical kinetics. While studying the variation in the polarization of fluorescent light he succeeded in determining the mean duration of the active state during which a molecule is susceptible of reacting. He also found certain factors which can shorten this duration and provide an explanation of negative catalyzers.

The chief of the division of chemistry is M. Georges Urbain, who, like M. Jean Perrin, is a professor in the Sorbonne and a member of the Institute of France. His name is intimately connected with the chemistry of the rare earths. His work on this subject has cleared up much of the confusion which previously existed. By means of systematic fractional crystallization and the use of bismuth as a differentiating agent he has developed a rational classification of the rare earths and has discovered the elements, lutecium and neoytterbium, the latter of which is now known as ytterbium.

GEORGES URBAIN, CHIEF OF DIVISION OF CHEMISTRY

His determinations of atomic weights have been accepted by the International Commission of which he is a member. Finally, attention should be called to his work on spectroscopy, magnetism, and cathode phosphorescence. The assistants of M. Urbain, who will be directly in charge of the work in the division of chemistry of the new Institute, will be Messrs. Levaillant and Augé.

The chief of the division of physiology is M. André Mayer of the College de France. He was among the first French biologists to employ physico-chemical methods in the study of the osmotic pressure and viscosity of the liquids of the organism. He also conducted some of the earliest researches upon colloids, the colloidal state, and colloidal complexes, as well as upon the action of radium on colloids and living cells. In the field of physiology he has been occupied with urinary secretion and the mechanism of the injections used in the control of diabetes. He has given much attention to developing the idea of the constant and characteristic composition of cells and tissues. His results show that certain elements are present in them in fixed proportions which may be considered as "cellular constants." The sum total of all these constants may be designated as "chemical biometrics." The most recent work of Professor Mayer is concerned with the relations between the composition of the cells and their function, particularly the oxidations of which they are the seat.

ANDRÉ MAYER, CHIEF OF DIVISION OF PHYSIOLOGY

The division of physiology is divided into a section of animal physiology and one of vegetable physiology. The former will be lodged in a separate pavilion connected with the main building by a closed passage way. It will be in charge of the young physiologist, Dr.

Th. Cahn, who was formerly at the University of Strasbourg. His laboratory will be provided with an aseptic operating room, as well as the usual research laboratories and necessary equipment required for physiological studies such as animal rooms, kitchens, etc.

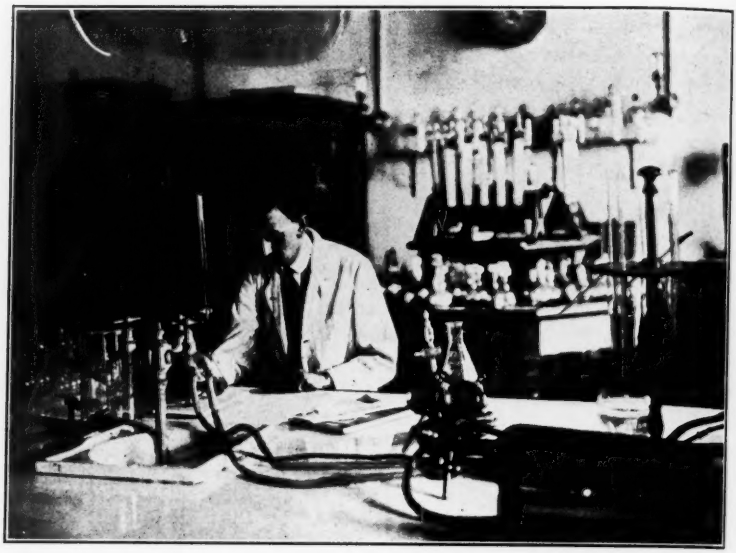
JACQUES DUCLAUX, CHIEF OF DIVISION OF COLLOIDS

The section of vegetable physiology, for which hot and cold plant propagating houses are being built, will be under the direction of Dr. L. Plantefol. This investigator has given attention particularly to the rôle of water in the life process of mosses. This work is designed to form the basis of a general biological study of the relation between the morphology, the physiology, and the ecology of a given vegetable species. Dr. Plantefol has also devoted considerable attention to the measurement of gaseous exchanges and has constructed for this purpose a eudiometer of high precision and published tables of constants for it.

RENÉ WURMSER, CHIEF OF DIVISION OF BIOLOGICAL PHYSICS

The division of physico-chemical biology is under the direction of Dr. Pierre Girard, who has devoted much attention to the part played by contact electricity and the polarization of membranes in biological phenomena. He has succeeded in preparing models which exhibit selective permeability, such as occurs through the cornea and ciliary vessels. More recently he has demonstrated an unstable electrostatic equilibrium in the case of a membrane functioning as a separator of ions. The passage of some of the ions of the molecules and not of the others in this case adjusts the equilibrium and remarkable catalytic oxido-reduction effects are obtained.

The direction of the Institute's efforts in the important field of colloids



EUGÈNE AUBEL, CHIEF OF DIVISION OF CHEMICAL BIOLOGY

has been delegated to Dr. Jacques Duclaux of the Pasteur Institute. He was among the first to give expression to the chemical theory of colloids. He also called attention at about the same time as McLewis and J. Perrin to the rôle of radiations in ordinary reactions.

The division of biological physics is in charge of Dr. René Wurmser who is the director of the laboratory of biophysics of the École des Hautes Études. His attention has been directed particularly to chlorophyllic assimilation and questions of photo-chemistry. His researches have also included problems of physical chemistry which arise in other types of synthesis, such as accompany the development of microörganisms. He has shown that the theory of oxido-reduction may find an experimental confirmation in the comparative study of cellular potentials and of the potentials of the various organic compounds which occur in organisms. These studies, which will be continued in the new Institute, have already furnished important information on the non-activity of oxygen in cells and upon the existence of a reversible form of sugar solely capable of entering into reaction with the acceptors of hydrogen.

The chief of the division of chemical biology is Dr. Eugène Aubel, formerly professor of biological chemistry at the University of Bordeaux. His work has been concerned with intermediate metabolism both in animals and in unicellular organisms. He has also given attention to oxido-reduc-

tions and their rôle in fermentations and synthesis. In recent years he has sought to substitute for the hypotheses based solely upon structure, which have guided the studies of intermediate metabolism, a conception founded on energy constants. By means of this he has developed an explanation of specific dynamic action which he is now subjecting to laboratory verification.

Finally, the chief of the division of experimental cytology is Professor Fauré-Frémiet of the Collège de France. He has studied and discovered many species of protistes, simple organisms which are neither animal nor vegetable. He is one of the pioneers in the study of the energetics of the development of the egg. He has also cleared up many points in the chemistry of the mitochondries, which are the minute bodies constantly present in protoplasm and which are apparently composed of a complex of protides and lipides. It is in his laboratory that tissue culture will be continued in the same manner as already so actively prosecuted in his laboratory at the Collège de France.

The new Institute of Physico-Chemical Biology will therefore bring together many scientists already widely known and admired, and of whom their past achievements are a certain guarantee of their future success. There will also be a large number of younger workers of whom much may be expected.

The combined efforts of this newly constituted group of highly trained scientists should certainly result in the solution of many fundamental biological problems and contribute largely to the advancement of science.

Cheap Aluminum Chloride. Aluminum chloride is a particularly effective reagent, but its high price has hitherto prevented its industrial use. It is thus of interest to note that Dr. McAfee, of the Gulf Refining Co., Texas, has developed a process whereby the price is reduced to only a few cents a pound. The process, work on which was started in 1915 and which has withstood patent litigation, is as follows: Bauxite ore (low in iron and silica) is calcined in an internally heated rotary kiln at 1800°F. and mixed with a good coking coal (bauxite 3 pts., coal 1 pt.). The mixture is then pulverized, mixed with a liquid binder (wax tailings, melted asphalt), briquetted under 3000 lb. pressure per sq. in. to 2-lb. briquets. These are heated to 1500°F. to remove hydrocarbons and moisture, the briquets then containing 82% bauxite and 18% carbon. They are then charged to the chlorinating furnace (internal diameter 5 ft., height 20 ft., capacity 40,000 lb. aluminum chloride per day), built of two courses of firebrick, protected by a layer of powdered bauxite with an external iron jacket fitted with inlets at the top for chloride and at the bottom an outlet for aluminum chloride leading through a cooler to iron pipe condensers. A charge consists of 20 tons of carbonized briquets, which are heated by a blast to some 1600°F., when chlorine is turned in for 8 to 10 hrs., and then the charge is replenished and heat restored. A lining has a life of about 100 days. The aluminum chloride made is used by the company for refining petroleum oils, but any surplus will be available for sale.—*Chemistry and Industry*

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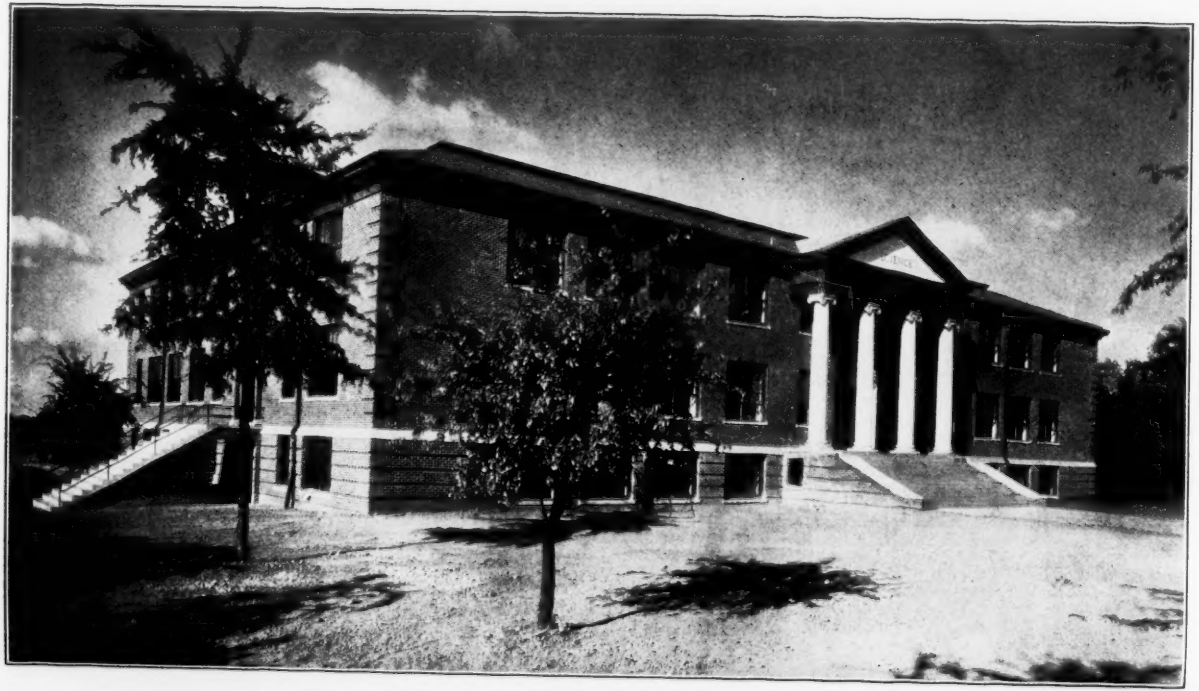

NEW SCIENCE BUILDING, MILLSAPS COLLEGE, JACKSON, MISSISSIPPI

THE NEW SCIENCE BUILDING AT MILLSAPS COLLEGE

J. Magruder Sullivan, Millsaps College, Jackson, Mississippi

At the inauguration some months ago of a building program for Millsaps College, Jackson, Mississippi, the citizens of Jackson and Hinds County accepted as their share of responsibility the contribution of $150,000 toward the erection of a new and thoroughly up-to-date Science Building, which had been a recognized major need of the institution for a number of years. In less than two weeks the amount sought was exceeded, and on Thursday, November 29, 1929, Thanksgiving Day, this new and beautiful $200,000 Science Building was dedicated. It was a "red letter day" in the history of Millsaps College. Representatives from thirty-five colleges and universities, as well as of a few scientific societies, gathered in the new building with members of the faculty, board of trustees, and alumni, who felt especially honored in having present as the chief speaker of the occasion, Dr. Robert Andrews Millikan. After the registration of guests and visitors, the body proceeded to the main assembly room in the Administration Building for the exercises of the morning.

Dedication

The following account of the forenoon program is an extract from the official report made by Professor H. Conrad Blackwell:

"The President, Dr. D. M. Key, presided at the exercises and stated in his brief introductory address that 'the completion of Science Hall is a monument to the loyalty and generosity of the citizens of Jackson and Hinds County, as well as the fulfilment of a long cherished hope by older members of the faculty.' Dr. Key paid fine tributes to Dr. J. M. Sullivan, professor of chemistry, and to Prof. G. L. Harrell, of the physics department, who have worked faithfully for the construction of Science Hall.

"The president next presented to the audience Mayor W. A. Scott, who presented the building for dedication. Jesse T. Calhoun, vice president of the Board of Trustees, accepted the building on behalf of that body. In his address of acceptance, Mr. Calhoun said:

> We, the trustees of Millsaps College, deeply appreciate this gift. The citizens of Jackson and Hinds County have been most liberal in their contributions which have materialized into this, the finest building on our campus.
>
> During all these years Jackson has furnished the churches in which our students have worshiped and the homes in which social life has been cultivated. Now, Jackson and Hinds County are furnishing the Science Building for intellectual improvements. This college will be able to serve in a much larger way because of this building. The sciences mean more now in the educative process than ever before because of our dependence upon advantages brought to us by science.
>
> The trustees of this institution desire that the whole truth be sought for diligently without the least fear. Much that was in our textbooks in science thirty-five years ago, when it was my good fortune to attend this institution, seems to have been discredited. Much that is known now was unknown then. Nature's laws were the same then as now,

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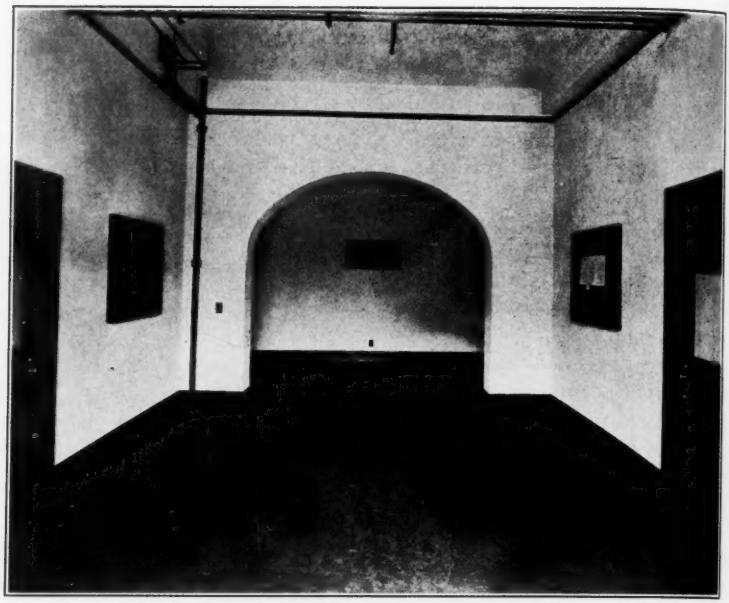


CORRIDOR, FRONT ENTRANCE

Stone tablet, shown on wall between entrances to main lecture room, was donated by Dr. J. M. Sullivan, professor of chemistry, and exhibits the only inscription in the building:

"Ye shall know the truth, and the truth shall make you free."

but man's conception of them is not the same. Man's conception of the truth changes, but the truth does not change. It is not the forces of nature which have made us what we are, but the discovery and use of these forces. Many things remain yet to be discovered and many forces remain yet to be harnessed.

We do not fear the truth, and we do not fear that the instructors in Millsaps College shall lead the youth astray in their search for the truth. When science is taught by scientists who have had religious experience, we do not fear for the religious life of those who are taught. Such instructors, when they have gone as far as knowledge goes, they then by faith lead toward the great Creator and not away from him. It has always been, and will continue to be, the desire of the trustees of this institution to select such instructors as those just mentioned.

"Following Mr. Calhoun's address, Dr. H. H. Sherman addressed the gathering on behalf of the church-at-large, declaring that the erection of Science Hall marked another milestone in the progress of Millsaps College. Dr. Sherman said the erection of the building indicates that Millsaps is keeping pace with the highest ideals and demands of the present day, and is no longer just a college of liberal arts that limits its work to literature,

philosophy, and old time courses, but is taking her proper place along with other great educational institutions of the country.

Millsaps as a Church College, continued Dr. Sherman, says that science is no enemy of religion, and there is no conflict between the two when properly understood and taught. The apparent conflict is in the minds of third-rate scientists and shallow religionists. Millsaps as an institution of the Church, in opening and dedicating, accepts the responsibility and recognizes her obligation to teach science in such a way that it will reveal God and conduct youth through the wonders of modern scientific investigation and discovery in such a reverent attitude that they will find the God of the universe along the way as well as at the end of the day.

"The main address of the day was delivered by Dr. Robert Andrews Millikan, chairman of the Executive Council of the California Institute of Technology, Pasadena, California, winner of the Nobel Prize in Physics in 1923 and world-renowned scientist."

THE PLACE OF SCIENCE IN THE MODERN WORLD*

ROBERT A. MILLIKAN, CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIFORNIA

The cardinal doctrine in the creed of every man of science is stated in the motto of the University of Chicago, namely, "*Crescat Scientia, Vita Excolatur*"—let knowledge grow, let life be enriched; or equally well in the motto of the California Institute, "The truth shall make you free." And any effort to suppress or impede the growth of science, which means to the scientist merely the growth of man's understanding of his world, and hence of his ability to live wisely in it, is to him an unpardonable sin, or at least not the work of an understanding mind.

If we are to be asked deliberately to shut our minds to the truth, or to be deterred by fear from searching for it, we might as well, so says the scientist, give up the effort at intelligent living altogether and go back to savagery. Furthermore, the whole history of man's age-long rise from superstition and ignorance up to his present estate seems to the scientist to be a practical demonstration of the essential soundness of this view.

So when a couple of years ago the Bishop of Ripon suggested to the meeting of the British Association for the Advancement of Science that it would be well for the world if science could take a ten-year holiday, his words did not meet with a chorus of applause from scientists.

But the Bishop's views are not so uncommon, and we scientists have to some extent been responsible for them. The following quotation from a book written by one of the best-informed and most intelligent of living

* Reprinted by courtesy of *Scribner's Magazine*. This article appeared in the February, 1930, issue of that magazine, pages 119–29, under the title of "Alleged Sins of Science." We have included this article in the JOURNAL in order that the account of the dedication exercises of the new science building at Millsaps College, Jackson, Mississippi, may be complete.

Americans states the case against science thus. I quote from Mr. Raymond Fosdick's recent book entitled, "The Old Savage in the New Civilization."

Humanity stands today in a position of unique peril. An unanswered question is written across the future: Is man to be the master of the civilization he has created, or is he to be its victim? Can he control the forces which he has himself let loose? Will this intricate machinery which he has built up and this vast body of knowledge which he has appropriated be the servant of the race, or will it be a Frankenstein monster that will slay its own maker? In brief, has man the capacity to keep up with his own machines?

This is the supreme question before us. All other problems that confront us are merely its corollaries. And the necessity of a right answer is perhaps more immediate than we realize. For science is not standing still. In speaking of the scientific revolution I have not been speaking of a phenomenon that was confined to the Nineteenth Century. Rather we are just at the beginning of the revolution. We could not stop it if we would. It is advancing by leaps and bounds, gaining in impetus with each year. It is giving us more machines, faster machines, machines increasingly more intricate and complex....

Life in the future will be speeded up infinitely beyond the present. Sources of energy will be tapped and harnessed far outrivalling what we have today. There lies in full view before us a realm of discovery in physical science till now untrodden by mortals even in their dreams. The pioneers are already upon the road to this promised land....We now know that in atoms of matter there exists a store of energy incomparably more abundant and powerful than any other of which we have thus far obtained control. If once we can liberate this force, what machines we can build. Steam and electricity will be an anachronism at which our children will laugh as we laugh at the hand loom and the spinning wheel. With a pound weight of this radioactive substance we will get as much energy as we now obtain from 150 tons of coal. Or another pound weight can be made to do the work of 150 tons of dynamite.

One hundred and fifty tons of dynamite—enough to blow a modern city into oblivion—compressed to a pound weight which might be held in the hand. No wonder that a sober-thinking scientist like Professor Frederick Soddy of Oxford University should write: "I trust this discovery will not be made until it is clearly understood what is involved." "And yet," he goes on to say, "it is a discovery that is sooner or later bound to come. Conceivably it might be made tomorrow."

One has only to turn the pages back to 1914 to find the grounds for Professor Soddy's uneasiness. All the machines that ingenuity could invent were directed to the single purpose of human destruction. In a hundred laboratories, in a thousand arsenals, factories, and bureaus, physics and chemistry were harnessed to the task of mass death. The gigantic success of the enterprise is shown in the statistics: 10,000,000 known dead soldiers; 3,000,000 presumed dead soldiers; 13,000,000 dead civilians; 20,000,000 wounded; 3,000,000 prisoners; 9,000,000 war orphans; 5,000,000 war widows; 10,000,000 refugees.

This was the tabulation that our mechanical civilization made possible. This is the result of creating machinery for which we have no method of control. This is the consequence of giving children matches to play with....

This, then, is the problem: science will not wait for men to catch up. It does not hold itself responsible for the morals or capacities of its human employers. It gives us a fire engine with which to throw water to extinguish a fire; if we want to use the engine to throw kerosene on the fire, that is our lookout. The engine is adapted to both purposes. With the same hand, science gives us X-rays and machine guns, modern sur-

gery and high explosives, anesthetics and poison gas. In brief, science has multiplied man's physical powers ten thousand fold and in like ratio has increased his capacity both for construction and destruction. How is that capacity to be used in the future? How can we hold in check the increasing physical power of disruptive influences? Have we spiritual assets enough to counterbalance the new forces? How can we breed a greater average intelligence? Can education run fast enough, not only to overcome the lead which science has obtained, but to keep abreast in the race? Can the old savage be trusted with the new civilization which he has created?

These are ugly questions. They are hurled as a challenge at our generation, and upon their answers the future depends.

Now perhaps the alleged sins of science have never been stated more tellingly than in the foregoing, and I would like to ask you to allow me to bring Science herself to the witness stand and ask her what she has to say for herself.

She replies very quietly that there are both statements and implications in the foregoing that need further consideration. First, that, following her conviction that the only matter of supreme importance is to find out the facts, since we have to live with them anyway, she has kept steadily at work since Mr. Soddy raised the hobgoblin of dangerous quantities of available subatomic energies and has brought to light good evidence that this particular hobgoblin—like most of the bugaboos that crowd in on the mind of ignorance—was a myth; that it was exceedingly fortunate that Mr. Soddy's fears did not at the time he uttered them induce a terrified humanity, like a frightened child paralyzed by its fear in the dark, to stop its efforts to get more light, for the worst disasters have always come from panic born of ignorance; that she (Science) regards it as her chief function to deter men from over-hasty conclusions, though she does not always succeed, even with her devotees; that her influence, nevertheless, is always to constrain men to replace panicky, emotional acting by reflective, informed, rational acting. The great world explosions, including the World War, have been mental, not physical. She would ask you then to withhold your judgment until all the available evidence is in.

Now the new evidence born of further scientific study is to the effect that it is highly improbable that there is any appreciable amount of available subatomic energy for man to tap; in other words, that henceforth men like the Bishop of Ripon who are living in fear lest some bad boy among the scientists may some day touch off the fuse and blow this comfortable earth of ours to star dust may go home and henceforth sleep in peace with the consciousness that the Creator has put some fool-proof elements into his handiwork and that man is powerless to do it any titanic physical damage anyway.

This may relieve the Bishop of Ripon, but it will disappoint men like Lord Birkenhead, who have been hypnotized rather than scared by the prospect of tapping enormous new sources of subatomic energy and who

have been reveling in the prospect of some day lying in bed, pressing a button, and calling for two atoms' worth of massage. These men will be obliged to give up their idle Utopian dream and console themselves with the reflection that the chief joy of life after all comes from the striving and the overcoming, that there is much more satisfaction in smashing a resistant atom, as man will doubtless do, than in lying on one's back and watching it explode.

One may become blue or happy, then, according to his temperament, over the fact that it is now highly improbable that we on the earth shall ever get any appreciable amounts of energy from any other source than the sun, whence we have always obtained our energy, directly or indirectly, in the past, but at any rate that is the indication to which we must adjust ourselves, and it serves at least to remove from the account of Science one sin with which she had been charged.

But that is only the first of the sins charged against her. What about the horrible indictment as to the twenty-six million people actually killed in the World War? The answer is two-fold. First, the implication was that Science had a good deal of responsibility for that war—an erroneous implication I think, since war has been the chief business of all the glorious civilizations of the past when there was no science, and with every advance in science I think it becomes less and less so. Indeed, primitive man's chief tools were probably arrowheads and tomahawks and his chief industry, making and using them. When the age of bronze replaced the age of stone a multitude of new peaceful arts were born. Coppersmiths, silversmiths, goldsmiths appeared who developed a wonderful decorative art for use on urns, on vases, on table ware, on personal ornaments, on sarcophagi, on friezes, on monuments—witness the amazing perfection of these arts revealed in Tutankhamen's tomb—and these arts reduced the relative importance of the successor of the arrowhead and tomahawk maker, for these peaceful arts turned men's minds and energies and interests away from war toward peace.

And this has been the consequence I think of practically every advance in science and its applications since that time. Let him whose eyes have recently been focused on the increased effectiveness of tools of destruction and whose fears have been aroused lest the savage in man may use these tools to destroy the race lift up his head and look all around him. I think that such a survey will show conclusively that every scientific advance finds ten times as many new, peaceful, constructive uses as it finds destructive ones. Explosives and fertilizers are basically the same, and even explosives as such meet a dozen peaceful needs to one warlike one. The du Pont Company is known as a powder concern, but that is a well-nigh negligible part of its business. Public thinking is misled merely by the fact that a horror makes better news than a wheat crop. One man blown

painlessly to atoms gets more news space than a thousand men in the agonies of starvation or dying by inches from disease. Steel does indeed make bayonets, but it also makes ploughshares and railroads and automobiles and sewing machines and threshers, and a thousand other things whose uses constitute the strongest existing diverter of human energies from the destructive to the peaceful arts.

In my judgment war is now in process of being abolished chiefly by this relentless advance of science, its most powerful enemy. It has existed in spite of religion, and in spite of philosophy, and in spite of social ethics, and in spite of humanitarianism and the Golden Rule, since the days of the cavemen because, in accordance with the evolutionary philosophy of modern science, and simply because, *it has had survival value*. It will disappear like the dinosaur when, and only when, the conditions which have given it its survival value have disappeared, and those conditions are disappearing now primarily because of the changes in world conditions being brought about by the growth of modern science.

I am with Mr. Fosdick in every effort to arouse more fully the social sense, the conscience, and the morals of mankind, in every effort to develop a new machinery like a world court and a League of Nations to assist in bringing about better international and social relations. If I differ with him at all, and I am not sure that I do, it is only in my estimate of the *relative effectiveness* of the different available agencies. He seems to fear too active experimenting in physics and its applications, but not in sociology, for when he is dealing with the latter field he says, "We need not fear that we shall progress too fast. The overwhelming danger is that we shall not be able to progress fast enough."

My own reason for exactly reversing this emphasis is very precisely stated by him in the following words: "But social science today is still lacking in the fundamental groundwork of knowledge. It is still too largely based upon inspiration rather than upon facts." My own position stated in one sentence is that all progress comes from knowledge, and I am enthusiastically for everything that increases knowledge, whatever be the field, sociology or physics, and for acting upon that knowledge when found. But it is as unsound to talk about the danger of too much knowledge in physics as in sociology.

For look farther at what is actually happening, at what kind of effort is today yielding the largest social returns. Without aiming directly at doing so, modern science and its applications have within the past fifty years actually produced the most profound and beneficial social changes that the world has ever seen. They have raised the average working man's wage in terms of actual buying power about fifty per cent in forty years, and that along with a twenty per cent decrease in his working hours. That is not everything, but it is the necessary first step, the indispensable foun-

dation upon which all other kinds of building must rest. Also, according to recent "Carnegie" studies, modern science and its applications have actually resulted in increasing the amount of reading done by the average man in Middle Town more than three hundred per cent, and this applies, too, to magazines like the *Atlantic Monthly* as well as to other grades of reading matter. Also, they have given the average man, through the radio and the "movie," the opportunity for education and entertainment (partly abused, no doubt, but partly utilized; and in any case opportunity is a *sine qua non* to progress)—opportunity such as the common man never had before.

One continually hears complaints that our machine age, with its mass production, has ruined the life of the common man, that it has deadened and routinized labor and taken away the joy of craftsmanship. These protests are natural, because the man who is taken through a modern factory and does not look beneath the surface of things will easily gain such an impression. A very superficial glance at the Ford factory, for example, would seem to justify the worst charges that are made against our machine age, but to the man who is capable of seeing beyond his nose it is a very different picture that unfolds itself. This man sees not merely the 8400 cars turned out each day by routine labor in the summer of 1929 by the Ford plant, but he looks beyond to see what these cars are doing to the life of the common man. He sees, in the first place, that these eight thousand cars are driven by roughly as many persons, and he realizes that driving a car in crowded streets is in itself a highly skilled occupation, which develops in large measure the qualities of sobriety, alertness, and intelligence. He contrasts the bleary-eyed, ruby-nosed old soak who thirty years ago sat on the driver's seat of the average cab in London or New York with the highly skilled chauffeur of today, alert, self-respecting, sober, intelligent, and well dressed. The change is striking and the improvement enormous.

Secondly, he sees that every one of those 8400 cars turned out in one day has to be taken care of and repaired by an intelligent garage mechanic and "trouble man," a man who must understand the intricate mechanism of an automobile from top to bottom and from one end to the other, who must be able to find the difficulty no matter where it appears, and, more than that, who must know how to right it. No such requirement of expert knowledge, no such variety of stimulating activity, was ever the lot of any middle-age artisan, and no such demand for intelligence was ever made before upon so large a fraction of the population as is now made by our mechanical age.

Thirdly, he sees that all these 8400 Ford cars turned out per day must be serviced by thousands of wide-awake, courteous, attractive service-station men—men who have taught the world as it has never been taught

before that the maximum of success is definitely related to the maximum of cheerfully rendered service to one's fellows. He sees that back of these service-station men are the refineries, with their expert staffs of chemists and physicists, and that back of these are the geologists and the seismologists and the radio engineers of the producing company, and so on without end.

As I read history the machine age taken in its entirety has actually freed, educated, and inspired mankind, rather than enslaved it. Even the few routine men who feed the machines in Mr. Ford's factory are less routinized and have shorter hours than the dumb agricultural drudge who hoed potatoes for twelve hours a day through all the history of the world before the machine age appeared.

But the far-seeing man will see even deeper than that. It is science and its applications that, through the Ford car and its like, have given to the average man and his family the opportunity for the broadening influences of travel, an opportunity that he is utilizing amazingly, too. It is science and its applications that, through the wonderful development of the art of communications, and through incredible stimulation and acceleration of trade and commerce, have knit the whole world together into a unity that makes war an anachronism. Much more important than treaties, I think, in abolishing war as an instrument of national policy is the growing recognition of the fact, taught in no uncertain language from 1914 to 1918, that in our modern scientific civilization war is no longer well adapted to the attainment of national ends. Let no man henceforth ever make the error of assuming that modern science made the last war. Rather was war, let us hope, the last titanic struggle of militarism to escape the extinction foredoomed for it in a world motivated by modern science. The World War was surely not a sin of science.

Again, can science escape the responsibility for those twenty-six million lives lost during that war? That is a matter of opinion. Granted only that these people could all have got to the fighting line, which, mind you, was of wholly unprecedented length, I am not sure that, with only ancient man's weapons, the sword, the shield, and the spear, given the World's War issues to fight about, the thirteen million who died in battle might not have been even more; and without modern medical science the thirteen million civilian deaths would almost certainly have been augmented.

But that is after all not particularly important. The significant fact is one brought out by Mr. Fosdick himself when he says, "Stop the machines and half the people in the world would perish in a month." That is not an overestimate. Modern science undoubtedly made it possible for more than twice as many people to live comfortably in Europe before the war as could otherwise have done so. Robert Fulton predicted in about the year 1800 A. D. that the time would come when England,

then thought densely populated, would hold 10,000,000 souls. Today she has five times that number. It was but a small fraction of these people, people who owed their very existence to science, who had been created by science, that lost their lives in the war. Had preceding generations abolished or slowed up science, more than this number would have died more miserably, *i. e.*, with greater suffering, for disease with science is bad enough, while without science it is hell.

Now the balance of this whole account shows scarcely a sin to be credited to science. Looked at in the large, I do not think there can be the slightest question that the only hope this world has of maintaining in the future a suitable balance between population and the food supply is found in science. That, in the last analysis, is mankind's greatest problem. Its solution alone, and there are the best of reasons for believing that in the long run it can be solved, is sufficient to warrant the fullest stimulation of both the biological and physical science that can in any way be brought about.

So far in my search for the sins of science I have failed to find her guilty of the charges brought against her, but to me there is one very regrettable tendency in modern life for which science is probably to some extent at least responsible. I refer to the craze for the new regardless of the true, to the demand for change for the sake of change without reference to the consequences, to the present-day widespread worship of the bizarre, to the cheap extravagance and sensationalism that surround us, as evidenced by our newspapers, our magazines, our novels, our drama, our art in most of its forms, our advertising, even our education.

These are, I suppose, inevitable, though I hope transient, accompaniments of the stupendous *rate of change* that modern science and its applications have forced on modern life. The spirit of change has been caught *where its basis has been wanting*. In this particular our generation stands unique in all history, and it is difficult to see how the future can have any other period of such rapid change in store.

In the way he conducted his daily life, my grandfather is undoubtedly more remote from me than he was from the earliest man mentioned in recorded history. In the last analysis this change is primarily due to the introduction of the power machine as a substitute for animal muscle, for this includes everything that has come to this generation through the steam engine, the dynamo, the automobile, the airplane, the telephone, and the radio. Add to this the change in mode of thought due to the new host of discoveries, primarily in physics and biology, and it is no wonder that our age has become infected, or better drunk, with the spirit of change. *In many fields no past time has known and no future time can know* so sudden and so complete a transformation, for the whole gamut of possibilities has been run through by our single generation. In woman's dress, for exam-

ple, the limits are obviously zero and infinity, and whatever there is in between that has not been tried since 1900, isn't likely to be tried very soon, nor would it represent a very large change if it were, so that whatever zest and joy there be in something brand new and radically different in this domain has been tasted to the full by this generation, and will never be tasted in such completeness again.

In physics and its applications these changes have been made by men who were fully conversant with the past, men who knew the difference between perpetual-motion cranks and real discoverers, men who knew the fully verified laws of the future for the whole range of phenomena for which their correctness had been tested; in a word, men who knew that Einstein would have to contain the whole of Newton, *i. e.*, be merely a refinement of, and supplement to, Newton or else that his work would be wrong. But unfortunately many of the other fields in which the spirit of change is rife have no such criteria for past or present truth as physics possesses and no such group of well-trained, capable, and historically informed minds working in them, so that in these fields we cannot be certain whether the changes represent progress or retrogression. In such cases, however, the counsel of the wisest heads of the past is the only possible guide for the present.

Be that as it may, I suppose that the present spirit of revolt, of change for the sake of change, the present effort for the new at all costs, the bizarre, the extravagant, the sensational, is in part an inevitable reflex of the rapid changes taking place in our times because of the rapid growth of science. When I go into an exhibition of the so-called secessionists in art in Germany I feel certain that I am in a madhouse, or when I read the literature poured forth by what Mr. Stuart Sherman called the emetic school of modern American writers, I dislike to admit that these modern excrescences of our civilization are a part of the sins of science, but I suspect the spirit of change which we have started has been partially responsible for them.

Yet I am not greatly disturbed even by these. The world will become sick of the emetic school in time. The actual method by which science makes its changes is becoming better understood. The demand for the saner popular books upon it is continually increasing. The remedy is in part at least in understanding it better.

As soon as the public learns, as it is slowly learning, that science, universally recognized as the basis of our civilization, knows no such thing as change for the sake of change, as soon as the public learns that the method of science is not to discard the past, but always to build upon it, to incorporate the great bulk of it into the framework of the present, as soon as it learns that in science truth once discovered always remains truth, in a word that evolution, growth, not revolution, is its method, it

will I hope begin to banish its present craze for the sensational, for the new regardless of the true, and thereby atone for one of the sins into which the very rapid growth of science may have tempted it.

But there is another side even to this admitted sin which will appeal to those of us who want to speed up social change, to those who feel that many of our laws and customs have actually become outgrown, that they were developed for, and were adapted to, the old civilization, not to the new. In many, many instances this view is undoubtedly correct, but here the sin just now admitted becomes a virtue. That the spirit of change is in the air obviously helps rather than hinders in the case of these needed social readjustments. The whole question however is, "Do we know enough yet to make any particular change?" The answer is sometimes yes and sometimes no.

In the latter case the new knowledge that is still needed is just as likely to come from further physical experimenting as from further social studies. The whole history of science shows that it is impossible to predict beforehand where a new bit of knowledge is going to fit in. The amazing thing about that history is the extraordinary rapidity with which each new advance in one domain actually finds its application in another. Physical knowledge *is* social knowledge! Let us not then hold back anywhere in the search for knowledge. *Crescat Scientia, Vita Excolatur.*

There is one other sin that is charged against science, concerning which I wish to say a word, namely, the alleged sin of exalting the material at the expense of the spiritual.

If this means providing food and clothing and wholesome living conditions for millions upon millions of people who would otherwise die of starvation or otherwise drag out such miserable lives that their only recourse would be to dream of another life free from the miseries of this, then science must plead guilty.

The rise of science has undoubtedly filled mankind with a new vision of, a new hope for, and a new effort toward a better human existence than the world has known in the past. If this is exalting the material over the spiritual then she must again plead guilty.

The rise of science has undoubtedly shifted somewhat the relative emphasis of our thinking from individual-soul salvation to race salvation. If this is exalting the material, then she is again guilty.

But, as I myself use words, the foregoing facts do not mean the subordination of the spiritual to the material. I myself think that the aforesaid changes represent an increase rather than a decrease in what I call "spiritual values," *i. e.*, an increase in the essential spirit of the great teacher which was epitomized in the Golden Rule. The essence of Christianity is to be found, I think, in the altruistic teaching and living which Jesus felt to be his chief mission to spread on earth. I have no reason to

think that this spirit is on the wane. Even the membership in the Christian churches, which are the chief stimulants of it, is increasing, and a civilization built upon modern science unquestionably demands its further increase. For as society becomes more and more complex civilization cannot endure at all save as the individual learns in ever-increasing measure to subordinate his own appetites and impulses to the common good, to the group life wherever the two come into conflict. In other words, the development of the sense of social responsibility which, broadly speaking, is merely the spirit of the Golden Rule, or slightly differently stated, the stimulation of the "consciences, the ideals and the aspirations of mankind," must be done in ever-increasing measure in a civilization which is growing more and more complex and interrelated under the influence of modern science.

So much for the practical side of the question. There is also a philosophic side. Science is sometimes charged with inducing a materialistic philosophy. But if there is anything which the growth of modern physics should have taught it is that such dogmatic assertiveness about the whole of what there is or is not in the universe as was represented by nineteenth-century materialism is unscientific and unsound. The physicist has had the bottom knocked out of his generalizations so completely that he has learned with Job the folly of "multiplying words without knowledge," as did all those who once asserted that the universe was to be interpreted in terms of hard, round, soulless atoms and their motions. The Oxford biologist, John Scott Haldane, has recently written "materialism, once a scientific theory, is now the fatalistic creed of thousands, but materialism is nothing better than a superstition on the same level as belief in witches and devils."

The best possible cure for materialism is the following chapter from the recent history of physics. A hundred years ago, physics consisted of six distinct, sharply separated departments: Mechanics, Molecular Physics, Heat, Sound, Light, Electricity. The first partition between these compartments to be broken completely down was that between heat and molecular physics, when about 1850 heat was found to be not a substance, as had been supposed, but simply molecular motion. The next discovery was that radiant heat and light were not different categories of phenomena but essentially the same phenomenon, that they were both ether waves identical save for wave-length. The next great discovery, made by Maxwell and Hertz, was that electric wave phenomena are indistinguishable from light and heat save for wave-length, and all these phenomena of radiant heat, light, and electric waves then became fused under the general heading "ether-physics," still sharply separated from matter-physics and also from current electricity.

The next partition to go was that between current electricity and matter-physics, when electric currents were found to be the motions of electrons.

But one partition then remained, that between ether-physics and matter-physics. Quite recently this too is gone, and matter and ether waves are fused together in Einstein's equation and ether and matter become indistinguishable terms. Electrons are now both particles and waves, and light waves are also corpuscles. What does it all mean? Simply that there is an interrelatedness, a unity, a oneness about the whole of nature, and yet still an amazing mystery. Is it at all likely in the light of that history that we can long maintain air-tight compartments separating ether (or matter, whichever you will) from life and mind?

Now another finding of modern physics! With astonishing rapidity within the past twenty years man has extended his vision. He has looked inside the atom, a body one-millionth the diameter of a pin head, and found an infinitely small nucleus one-ten-thousandth the diameter of the atom and arranged about it as many as 92 electrons (in uranium) each playing its appropriate rôle in a symmetrical, coördinated atomic system. He has then looked inside that nucleus and counted in uranium exactly 238 positives and 146 negatives and he has found that the atom changes to something else if any one of these positives or negatives drops out. He has watched the interplay of radiation upon these electrons, both within the nucleus and out of it, and found everywhere amazing orderliness and system. He has learned the rules of nature's game in producing the extraordinarily complicated spectrum of a substance like iron, for example, and it is, in Sommerfeld's phrase, unbelievable *zauberei* (magic) that these complicated rules never fail to predict exactly the observed results. Again, man has turned his microscope upon the living cell and found it even more complex than the atom, with many parts each performing its function necessary to the life of the whole, and again he has turned his great telescopes upon the spiral nebulas a million light years away and there also found system and order.

After all that, is there any one who still talks about the materialism of science? Rather does the scientist join with the psalmist of thousands of years ago in reverently proclaiming "the Heavens declare the glory of God and the Firmament sheweth his handiwork." The God of Science is the spirit of rational order and of orderly development, *the integrating factor in the world of atoms and of ether and of ideas and of duties and of intelligence.* Materialism is surely not a sin of modern science.

I have thus found Science "not guilty" of most of the specific counts raised against her. But after this defense I am ready to go back to the quotation from Mr. Fosdick and join him in raising precisely the question he there asks. For in the last analysis that question is merely whether for any reason whatever, scientific or non-scientific, mankind, or more specifically this particular generation of Americans, has the moral qualities that make it safe to trust it with the immensely increased knowledge and

the correspondingly increased power which has come into its possession. I join him in throwing out that question as a challenge to our generation, for there can be no doubt that our generation has been getting hold of the sources of knowledge and of power at a rate such as no generation of the past has ever known, and so far at least as mechanical power is concerned such as no generation of the future is likely to know.

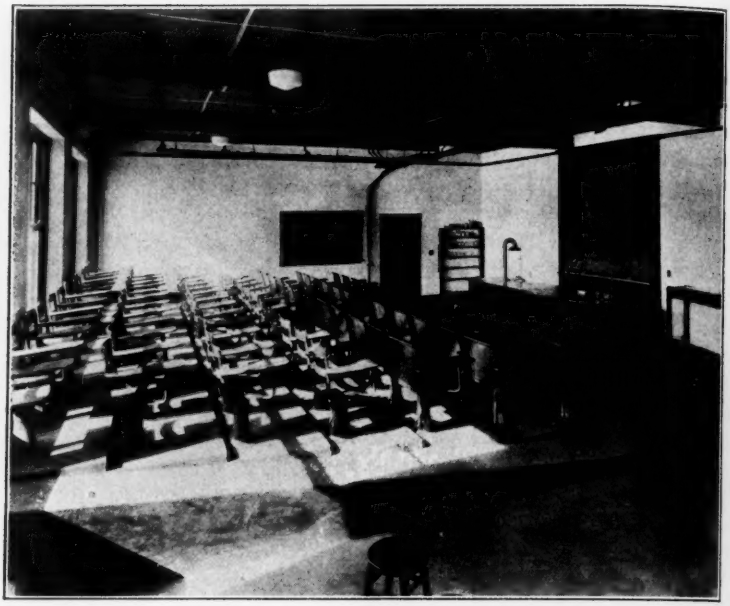
I am not in general disturbed by expanding knowledge or increasing power, but I begin to be disturbed when this comes coincidentally with a decrease in the sense of moral values. If these two occur together, whether they bear any relationship or not, there is real cause for alarm.

There are certain disturbing indications in America just now of such a coincidence. I will mention but two of them: the one is the obvious effort at the deflation of idealism, the ridiculing of the existence of such a thing as a sense of duty or of social responsibility, not, thank God, by scientists, but rather by a group of American writers which is apparently trying to create something brand new in morals; and the second is the apparently increasing lawlessness just now characteristic of American life. When we have now, and have had for twenty years, *i. e.*, for a time long antedating the advent of prohibition, sixteen times the number of murders per thousand of population than is found in England, there is some reason for alarm. Where individuals in sufficiently large numbers are willing to destroy the basis of confidence in themselves by refusing to be governed by the rules which they themselves, with the aid of their recognized and duly established and agreed upon machinery, have set up, then obviously the foundations of civilization are being completely undermined. If that spirit coexists with the destructive possibilities brought forth by modern science the danger is very great. The remedy, however, is obviously not to try to hold back the wheels of scientific progress, but rather to use every available energy, religious, social, educational, as individuals, as groups, and as a nation, to stay the spread of the spirit of selfishness, lawlessness, and disintegration. That, I take it, is essentially the challenge of Mr. Fosdick's book, and in that challenge I am quite ready to join with him.

At the close of these exercises a buffet luncheon was served to the guests in the Science Building, after which opportunity was given for inspection of the building, followed by witnessing the Thanksgiving football game. In the evening the visitors were guests of the president and faculty at a dinner served in Galloway Hall.

The Building

The building is in "E" shape, constructed of red brick and trimmed with Indiana stone. There are three floors planned for work in chemistry,

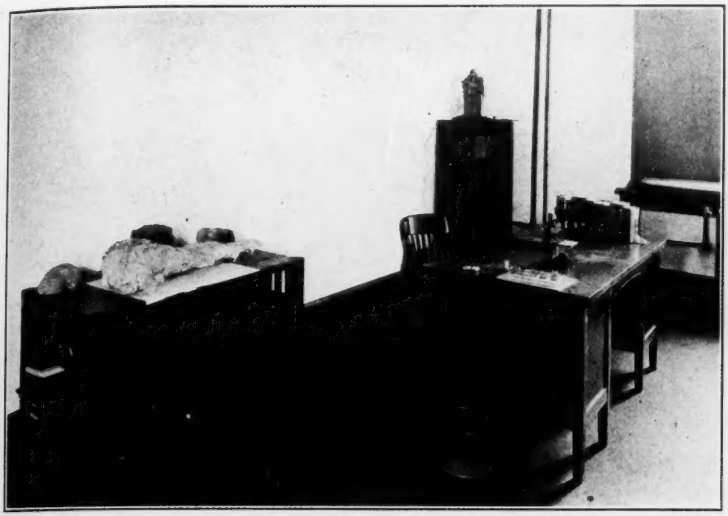


CHEMISTRY LECTURE ROOM WITH CAPACITY OF 84

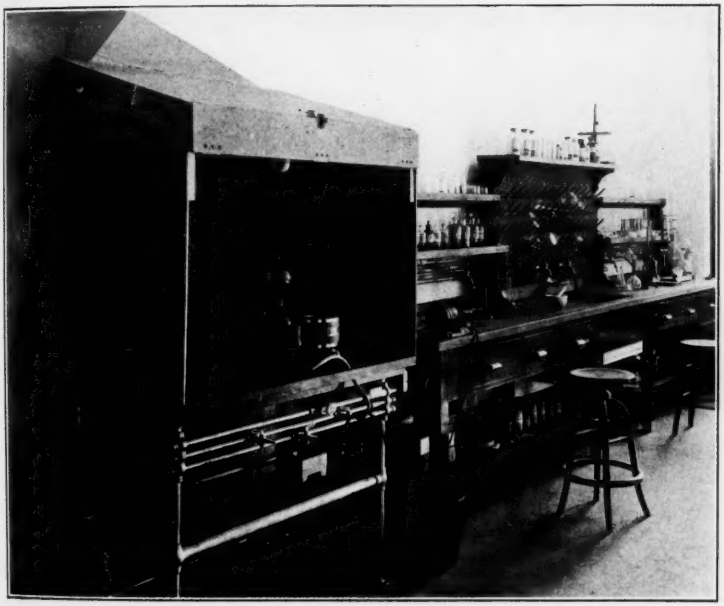
physics, biology, and geology, with a ground area of about 13,700 sq. ft. The basement floor is above ground level except along the front wall and here all windows are well above ground. On this floor are the general stockrooms, located conveniently with reference to the rear entrance and a freight elevator, besides two large and four small chemical laboratories, five physical laboratories, one geological laboratory, a shop, several darkrooms, and a room for the electric switchboard and automatic air compressor.

The first floor is devoted equally to chemistry and physics, the former to the right and the latter to the left of the main entrance. The front rooms comprise an office, a private laboratory, and a lecture room for the head of each department, and these rooms connect one with the other in the order named. In the commodious end wings are the large general laboratories, a number of smaller laboratories for specialized use, and small stockrooms. In the central wing is located a general lecture and assembly room with inclined floor, standard picture booth, and a seating capacity of 200.

The left half of the second floor is devoted to biology, including office, private laboratory, and lecture room for the head of the department, four large laboratories, and a stockroom. There are also on this floor



PRIVATE OFFICE OF PROFESSOR OF CHEMISTRY AND GEOLOGY



PRIVATE LABORATORY OF PROFESSOR OF CHEMISTRY AND GEOLOGY

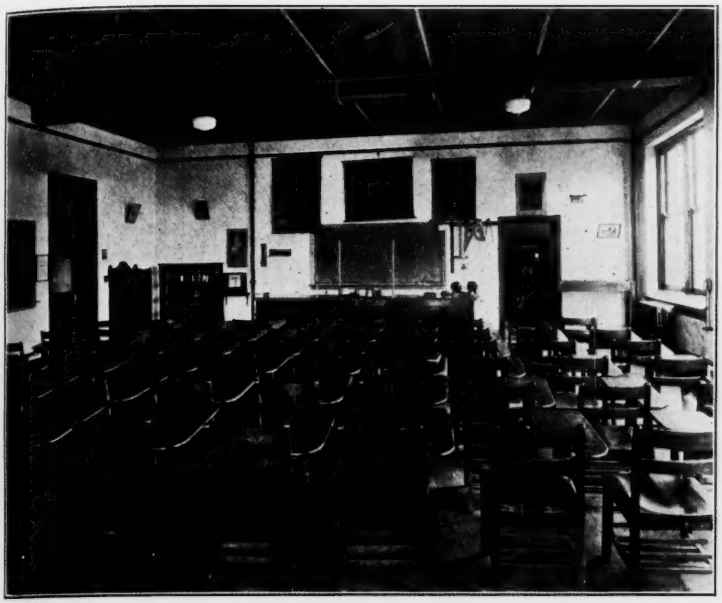
GENERAL CHEMISTRY LABORATORY
Capacity: 7 double desks, 18′, with 28 cupboards each; 5 are now installed.

laboratories for qualitative, quantitative, organic, and physical chemistry, a special stockroom for these, weighing room, assistants' office and laboratory, small reading room, and several small laboratories.

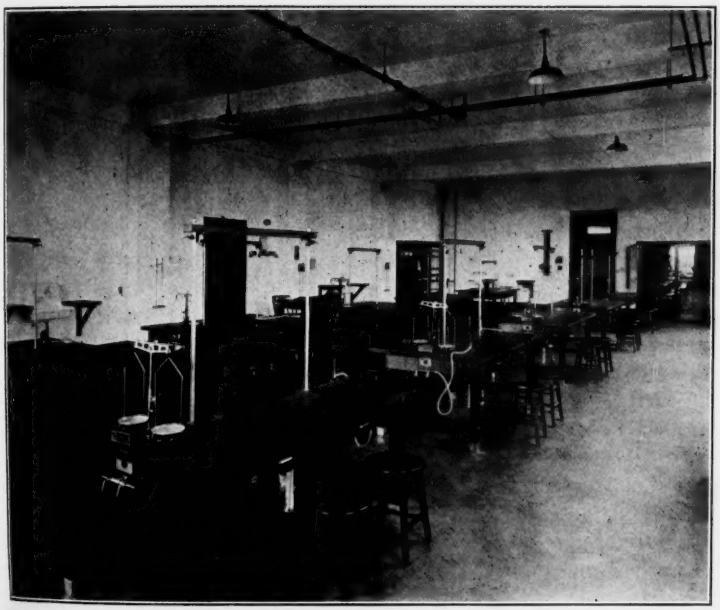
The attic is lighted both by windows and electricity, and motors, fans, and conduits are so located that large storage room is available.

It is the desire of the science faculty to encourage and develop students inclined to specialization in scientific fields, and also to stimulate the spirit of research. To this end ample laboratory space has been provided, and a few small research laboratories are being equipped for a limited number of capable and ambitious students.

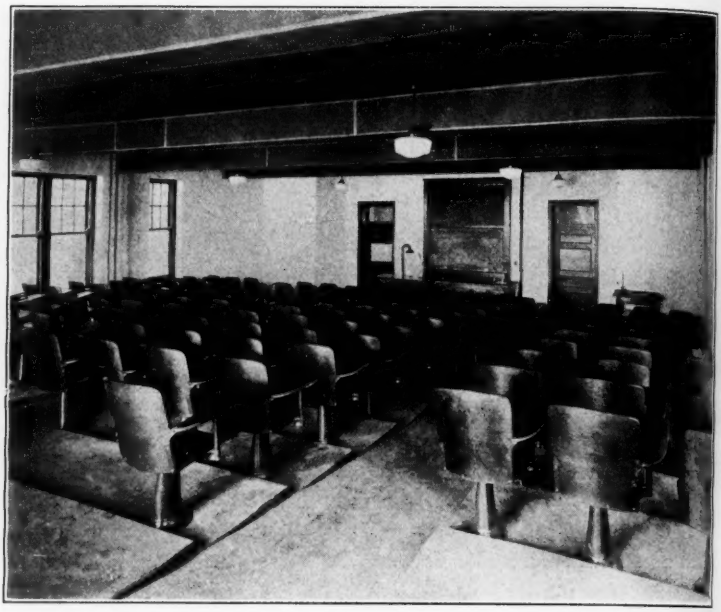
The floor plans as adopted had been worked out, with careful observations and consultations through a number of years by the professor of chemistry, now completing his twenty-seventh year at Millsaps College as head of the department of chemistry and geology. He has expressed appreciation of valuable suggestions and assistance received, especially from Professor G. L. Harrell, head of the department of physics in Millsaps College, Dr. J. N. Swan, head of the department of chemistry, University of Mississippi, Dr. C. E. Coates, head of the de-



Physics Lecture Room



General Physics Laboratory



GENERAL LECTURE ROOM WITH CAPACITY OF 200

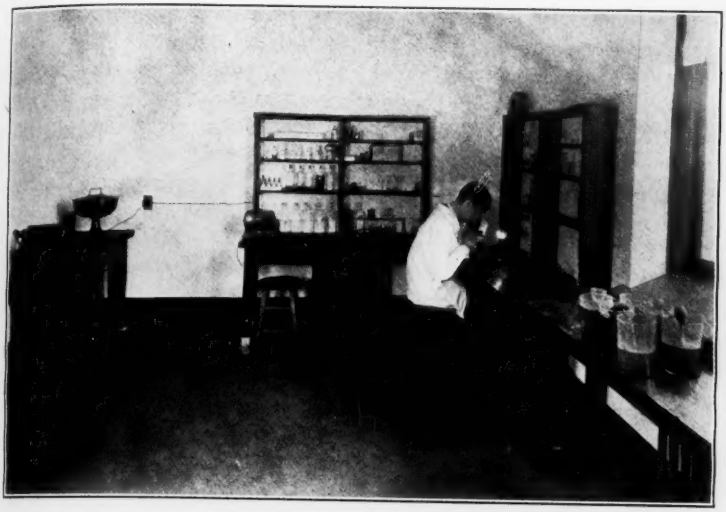
partment of chemistry, University of Louisiana, and Dr. L. M. Dennis, department of chemistry, Cornell University.

The Chemistry Section

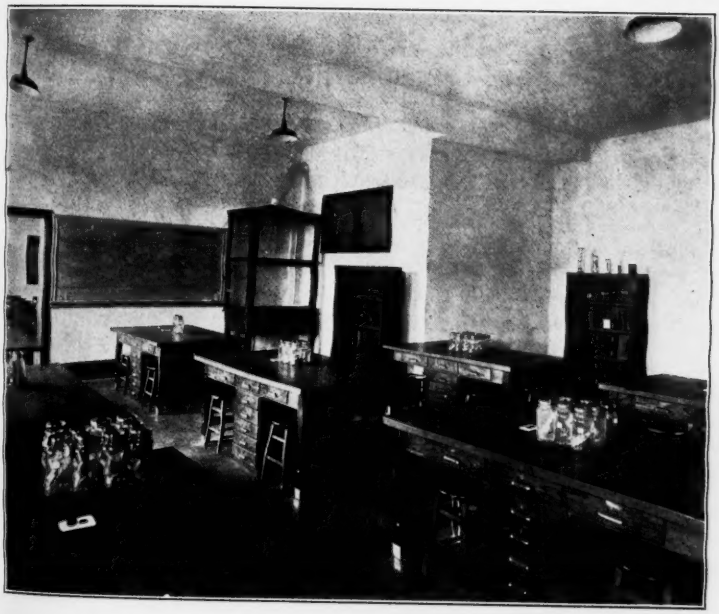
There are two lecture rooms supplied with fixed seats in elevated rows, standard lecture desks with Alberene stone tops and removable downdraft hoods, sliding blackboards with separate control for lighting, and other conveniences. There are four large laboratories and a number of smaller ones to take care of general chemistry, qualitative analysis, quantitative analysis, organic, physical, and industrial chemistry, nitrogen determinations, gas analysis, and research. There are several small rooms for individual and specialized work. The two larger laboratories accommodate seven double desks eighteen feet long and four hoods each six feet.

All desks have Alberene stone tops and sinks, with lead trough inclined the entire length in one direction to sink, and are supplied with an adequate number of outlets for water, gas, compressed air, and 110-volt alternating current. Each electric outlet is wired for 30 amperes.

All hoods are of the high velocity open-type, made of Transite board on Alberene shelf, supported on steel pipe frame, and range from four to



Small Biology Laboratory



A Biology Laboratory

eight feet in length. Each hood is provided with a small lead sink and outlets for water, gas, compressed air, and 60-ampere electric current. A special fused outlet box is provided to accommodate several pieces of electrical apparatus at the same time. There is a separate control for a light fixture attached to the ceiling of the hood.

All horizontal drain pipe is of Duriron. Floors are of "mastic," and lecture room ceilings are of Masonite board which eliminates all echo.

Three stockrooms for apparatus and chemicals are located on the basement floor convenient to a freight elevator. Two departmental stockrooms are located, one on the main floor with service window connecting directly with the laboratory for general chemistry, and the other immediately above with service window connecting directly with the qualitative and organic laboratory. The weighing room is located between the laboratories for quantitative analysis and physical chemistry.

Distilled water is supplied by gravity through block-tin pipe to laboratories on each floor and to lecture table.

The seven motors and fans that produce the ventilation for hoods and laboratories are located in the attic, each motor controlling a separate groups of hoods and its operation indicated at the control switch by light signal.

Packing Frozen Fruits in Containers. Packing frozen raw fruits, berries, and vegetables in small containers to preserve the original flavor of the fresh product is being studied by the Department of Agriculture. Last season 10,000 cans of fruits, berries, and vegetables were frozen packed by various methods and put in cold storage in the State of Washington. Packing of frozen raw fruits and vegetables in small containers is a new project in the food industry. The products are put up in vacuum-sealed tin cans or covered waxed paper containers alone or with sugar, salt, or other packing media, and stored at low temperatures until consumed.

The Department of Agriculture is conducting this experiment in order to better determine the quality of frozen packed products, for the benefit of officials enforcing the Foods and Drugs Act and to give packers accurate information. The packing was done at several Washington and Oregon plants where facilities were available for both vacuum sealing and paper-cup packing. The work was completed under regular operating conditions with accurate data gathered at every step.

The containers were placed in cold storage at various constant temperatures where they will remain for a while. Part of the pack will be shipped to the Washington, D. C., laboratories for examination by chemists who will determine the quality and condition of the fruits and vegetables so preserved. The remainder will be opened and examined at the places where stored. By checking between the quality of the product, the method of packing, and the temperature at which it was held in storage, the experimenters will know accurately the value of the different methods used.

The products packed include strawberries, raspberries, loganberries, blackberries, currants, pears, cherries, avocados, peaches, peas, cantaloupes, apricots, beans, beets, melons, sweet corn, and tomatoes.—*Ind. Eng. Chem.*

MY STUDENT DAYS IN GERMANY[1]

LeRoy Wiley McCay,[2] Princeton University, Princeton, New Jersey

Toward the end of the seventies, when I was a student here in Princeton, there was much talk and excitement about the development of the mining industry in the United States. The wonderful tales of the untold riches of the Comstock Lode at Virginia City, Nevada, of the recently discovered argentiferous lead carbonate deposits at Leadville, Colorado, of the masses of native copper in the Lake Superior district, and of the abundant occurrence of phosphatic rock in Florida and South Carolina, attracted my attention and aroused my interest, and led me to the conclusion that the profession of mining engineering should be a fascinating as well as lucrative one. At that time Professor Henry B. Cornwall had charge of the analytical chemistry in our School of Science. A classmate told me that Cornwall had the degree of mining engineer, and had studied in Germany at a noted mining school at Freiberg in Saxony. Being an academic student I did not know Professor Cornwall, but I took the liberty of calling on him at his laboratory, and requesting him to give me his opinion of the rank and reputation of this school. According to him it was the best of its kind in the world, because, first, Freiberg was situated in the midst of the Ore Mountains of Saxony, where mining, ore dressing, and smelting had been carried on ever since medieval times, and, because, secondly, all the lectures on these subjects were supplemented by practice in the mines, concentration and metallurgical works. He informed me further that all the great mining engineers, and most of the eminent mineralogists and geologists in our country were former Freibergers. So enthusiastic was he in regard to the matter that before leaving his office I had decided to go to Freiberg to study. I did not have to familiarize myself with the German language for before entering Princeton I had spent nearly three years at school in Dresden, a city, by the by, only some thirty miles from Freiberg. Let me digress a moment to say that in January, 1883, shortly after my return from Germany, it was on Professor Cornwall's request that I was called to Princeton to serve as his assistant. I have been here ever since—46 years.

I matriculated at the Royal Mining School in September, 1878, about two months after graduating from Princeton. One of the first things which struck me was the amount of freedom a student enjoyed. Attendance on lectures and laboratory exercises, and our presence in the mines and metallurgical works were purely voluntary. There were no quizzes and written tests, and no examinations, barring the one a man took when he came up for his degree. This *akademische Freiheit* (academic freedom) was greatly

[1] Paper read by Professor McCay before the Princeton Chemical Club, May 16, 1929.

[2] See "American Contemporaries—LeRoy Wiley McCay," by Wm. Foster, *Ind. Eng. Chem.*, **17**, 652 (June, 1925).

appreciated, and made the most of by the German High School, Polytechnicum, and University student. Since a boy of nine or ten he had slaved for nine years in a *Gymnasium*, or *Realgymnasium*, both under government control, so play in our sense was scarcely known to him. His education had been a drastic one, but the result was certainly worthwhile, for a more learned, a more capable, a more efficient young man it would be hard to find. The far-reaching importance of a satisfactory completion of the gymnasial courses will be evident when I say that failure to pass the final examinations debarred a man from entrance to the universities. Indeed, no delinquent could, if I remember correctly, ever hope to become a candidate for government employment. As to the nature of the preliminary training exacted of those who proposed entering the army and naval schools with the intention of becoming officers, I know nothing.

In my day there were in Freiberg students from all parts of the world—North and South Americans, Englishmen, Frenchmen, Russians, Swedes, Poles, Austrians, Italians, Spaniards, Greeks. There were even men from Japan and the Philippine Islands. In the circumstances I had an excellent opportunity to compare the *Abiturienten* (graduates) of the *Gymnasia*, where the chief disciplines were Greek, Latin, and mathematics, and those of the *Realgymnasia*, where no Greek, but Latin, mathematics, and modern languages were the important branches of study, with our college graduates as well as with those of other European schools. The *Abiturienten* of the German schools were by far the best educated of all—those of the *Gymnasia* came first and were followed by those of the *Realgymnasia*. The former not only led us in the theoretical and laboratory work, but their familiarity with the classics was remarkable. They had a fine command of language, and an ease and confidence in conversation which was delightful, but their acquaintance with French and, in many cases, with English astonished me. Most of them spoke French, and there were few who could not at least read English understandingly. Their aptitude and general information occasioned much comment among the American college men. The fact that, while their training had been for the most part classical, they mastered scientific and technical subjects with ease made a deep impression on me, for I had always supposed, when a student at Princeton, that the time devoted to a study of Latin and Greek was all lost, that the knowledge so gained could be of no earthly use to me as an introduction to courses in mining and metallurgical engineering. I was too young then to realize that it was the *mental discipline* developed by the study of the classics, which, so far as my future work was concerned, was the main thing. During the period spent in Freiberg I learned too that Greek and Latin are valuable not only as mental disciplines, but that an acquaintance with the literature of the ancients at once stamps a man as one of parts and, whatever his profession may be, admits him to companionship with the best minds.

The classical education which I received at Princeton was certainly a great asset in winning for me the attention and respect of my professors and the better class of students. The graduates of the *Realgymnasia* were also clever and attractive, eager, enterprising and enthusiastic, but, with few exceptions, they never seemed to equal those from the *Gymnasia*, a fact I can only attribute to the effectiveness of the Greek which, as I have said, was required in the *Gymnasia* along with Latin. I had also a good opportunity in those days to compare the classically educated American college man with the college graduate who had specialized at home in mathematics and the sciences with the view of preparing for his engineering studies. The former was decidedly the abler, and, so far as social influences and relations were concerned, by all odds the more attractive and companionable man. Later, while continuing my chemical and geological studies in Heidelberg I noticed the same thing. The Germans, Englishmen, Russians, Swedes, and others, who had been well grounded in the classics, were intellectually and socially the leaders. Such was my experience fifty years ago.[3] However, the times change and we change with them. The curricula of the two kinds of *Gymnasia* have undoubtedly undergone revision since my day—to what extent, however, and with what success I am unable to say.

The German students, in many cases, spent their first year in having a good time, which, in view of their years of slavery at school, they certainly deserved. Their divinities were "*Wein, Weib und Gesang*," or, perhaps, I'd best say, "*Bier, Weib und Gesang*," for the average student couldn't afford to quench his thirst with wine, except on special occasions. And let me say in passing that, in my day, every one in Germany seemed to be *idiopathically* thirsty. Students who were well born, or of the socially elect, and could afford it, joined a Corps, and derived much pleasure and satisfaction from dueling. I desist from saying anything in detail about the Schläger duels, for they have been talked about and written up *ad nauseam*. The results were rarely serious, a badly scarred face being the only disfigurement a man suffered. I use the term disfigurement advisedly, for these slashes were regarded by the Germans as marks of honor, and viewed with respect by all, especially the fair sex. Curiously enough the best swordsman at Freiberg in my day was an American from New Orleans who, although he had fought no less than twenty duels, had but a tiny scratch on his cheek, a scratch so small that it was barely visible. I recall two other American Corps students who were deeply enamored of this sport. They hadn't, however, the speed and skill of the chap from New Orleans and were, consequently, badly cut up. Sabre and pistol duels were rare, and only fought when honor was at stake. At first most of the Americans and Englishmen looked upon these duels as barbarous, and unworthy of a

[3] See my statement in "The Value of the Classics," by Andrew F. West, pp. 271–7.

highly cultured people, but in course of time our prepossessions waned, and the duel began to be regarded by us with the same leniency we showed for other customs not tolerated in our own countries. The fact, too, that many students from all parts of the Continent approved of the duel had much to do with mitigating our prejudices.

I cannot resist saying something about the cost of living in Freiberg at the end of the seventies and the beginning of the eighties. I lived on six hundred dollars a year. Of course this amount did not cover an occasional trip to France, Italy, and Switzerland. For a sitting room and bed room, both plainly but comfortably furnished and always scrupulously clean, I paid 20 marks ($5) a month. This included service. My most expensive meal was dinner, which cost a mark (25 cents). Sometimes, when hard up, I had to rest content with a 60 Pf. repast. Beer was always extra. North German beer cost 15 Pf., Bavarian, 20 Pf. a glass. A Pfennig is $^1/_4$ of a cent, and a glass holds 500 cm.[3] Beer was looked upon not only as a drink but, owing to the carbohydrates present, as a food. I realize that I am guilty of a gross breach of morality in referring, *coram populo*, to beer, for, nowadays, here in our country, the word is on the *Index Prohibitorius*. However, fifty years ago few German cities were provided with water works, and processes for purifying water. Practically all of it was gotten from pumps and shallow wells and, in consequence thereof, was highly charged with recent sewage contamination. "Abstain from drinking water and so preserve your health" was the advice given me by a prominent Dresden physician.

A good part of the summer of 1879 I spent doing my practical work in the mines, ore-dressing and smelting works in the Freiberg district, and in the summer of 1880 I was engaged in a like employment in the Hartz mountains. Two weeks of this period, before going to the Hartz, I devoted to a study of coal mining in some of the government mines near Zwickau in Saxony, and one week to work in the salt mines at Stassfurth.

During the spring vacations some of us, under Alfred Stelzner, our geologist, made excursions through Saxony and Bohemia. Delightful trips were they, and I look back upon the jolly times we had as among the most enjoyable I have ever experienced. Stelzner was a splendid fellow, and on our long and tiresome tramps he kept us continually in good spirits. One day, toward dusk, when we were approaching a tavern where we were to get dinner and spend the night, he suddenly exclaimed: "*Dort ist es—ach, wie freue ich mich über die Suppe, das Beefsteak, und den Salat!*" A burst of laughter from all of us—foreigners as well as Germans. "It sounds funny," he said, "but it is the purest German." And so it was. The soup is feminine, the beefsteak neuter, and the salad masculine.

Among the many men under whom I studied in Freiberg there were three who, although dead years ago, stand out on the mists of my non-ego

as clearly as were they alive and before me today—Weisbach, Richter, and Winkler.

Albin Weisbach was the professor of mineralogy, a well-built man with yellow hair, and a jolly red face which, however, rather startled you at first owing to a long and ugly scar which extended from below his chin up to and above his ear. This slash he had received in a Schläger duel when a student. After finishing his regular courses he suggested that I study in detail a number of rare cobalt, nickel, and iron pyrites. "You may," he said, "do the mineralogical work here in my private room, and the chemical analyses you could make in the chemical laboratory under Winkler's direction." I spent a year and a half on this investigation, and published it in pamphlet form in Freiberg in 1884. The chief observation was that the cobalt and nickel arsenides are isodimorphous. Cobalt arsenide, $CoAs_2$, and nickel arsenide, $NiAs_2$, occur in nature not only as smaltite and chloanthite in tesseral crystals, but also as safflorite and rammelsbergite in rhombic forms. Weisbach insisted on my doing some mathematical crystallographic work, and when I told him I was too busy to undertake it he asked me if I were pious and went to church on the Sabbath. I told him that while not over-pious I did attend divine service occasionally down in Dresden, but, in view of the compliment he paid me, I thought I could overcome the ecclesiastical urge. "Very good," he replied, "come to me Sundays at 10 A.M. and I'll show you how to use a goniometer and draw crystals." Once while making a social call at his house the bell rang and the servant girl entered and announced Messrs. X, Y, and Z. I instantly arose, shook hands and was leaving when he winked at me, and whispered, "*Todeskandidaten!*" They were three chaps who were coming up for their examinations, and were paying the prescribed call. He certainly had sized them up.

Theodor Richter, the rector of the school, was a nervous, high-strung, mobile little man, who had charge of the metallurgy, assaying, and blowpipe analysis. Although over-exacting perhaps in regard to the manipulative details of the last two disciplines, he kept us in a good humor by his wit and whimsical remarks. His skill in handling a blowpipe was astonishing. He manipulated this little instrument with as much dexterity as does a virtuoso his clarionet. Complete qualitative analyses of all sorts of minerals and rocks he made rapidly, and with the utmost ease, and his results were fully as correct as those obtained by the chemist in the wet way. With his blowpipe I have seen him make quantitative determinations of silver, copper, mercury, cobalt, and nickel which, when we consider the small amounts of ore worked on, were remarkably accurate. One day I requested him to tell me how he and Reich chanced to discover the element indium. "Come to my house Sunday at 11 A.M.," he answered, "and I'll tell you just how *I* ran across it." The use of the word *I* impressed me

tremendously, and at 11 sharp I put in an appearance. He began by talking of Kirchhoff and Bunsen's discovery of spectrum analysis in 1860, of the latter's discovery of cesium and rubidium in the mixture of salts obtained by evaporating the mineral waters of Dürkheim, and of Crookes' detection in 1861 of thallium. "We had," he went on, "a little spectroscope, and with its aid I was hunting for thallium, which my chief, Reich, thought ought to be present in Freiberg ores. This was in the summer of 1863. Some zinc blende when collected in the loop on the end of a platinum wire and brought into the flame of the Bunsen burner gave a vapor which, examined with the little spectroscope, disclosed a single blue line. I was alone at the time, and at first supposed that the line was one of the blue lines given by cesium. However, experiment proved that neither of the blue cesium lines coincided with the one I had in the field of view. In less than a quarter of an hour I knew I had discovered a new element. I at once reported my find to Reich, but he laughed at me, and told me I was crazy. My excitement, however, aroused his curiosity, and when I got him at the spectroscope I soon convinced him that I was right. Reich *had nothing to do with the actual discovery of indium*, although the work involved in isolating it, and preparing many of its compounds, we did conjointly." Such, so far as my memory serves me, was the account vouchsafed me by Richter in 1880 in regard to the discovery of the element indium. Both Reich and Richter were, at the time, chemists in the great Mulden Works. The most important work on indium, I may say in passing, was done later by Winkler, at the suggestion of Reich.

Of the three men, however, the one who appealed to me most was Clemens Winkler. He was in his early forties, of moderate height, thick-set, wore a short dark beard and, being a very dear friend of King Gambrinus, was pretty generously developed about the waist line. He had an attractive face, an engaging smile, and his voice, while low, had a peculiar penetrating power. The fact that, while a ready and fluent speaker when called upon at scientific gatherings, dinners, and Kneipen to make an address, he always read his lectures, and even took his manuscript to the board when he had occasion to write down equations, surprised me. His lectures on general as well as applied chemistry were extraordinarily gripping, for he had the power to communicate to his hearers the enthusiasm for the science which he himself possessed. He made his experiments himself and very rarely called upon an assistant for help. He was brimful of what the Germans call "*das chemische Gefühl.*" His German was simple, straightforward, not a bit involved, and the long, ponderous, exasperatingly intricate and quite untranslatable sentences in which so many of his countrymen gloried were shunned by him. He knew little French and less English, but he was a master of his own language. It was pretty well agreed by the chemists all over Germany that Winkler's literary style left little to be desired, that

it was equaled only by that of A. W. von Hofmann of Berlin. His good nature, his winning manner, his generosity, his bonhomie, and his keen social instinct captured the love of all, students, colleagues, and fellow citizens. Even the loafers in his laboratory, whom by the way, he generally avoided, as well as students who failed to pass their examinations, always referred to him in the highest terms. In my day he was the most popular man in Freiberg.

CLEMENS WINKLER IN 1882

No lectures were given in analysis. Each student was told to provide himself with a copy of Fresenius, get busy and consult the assistant when in doubt. The *Bergrath* (we always gave him this title) walked through the laboratories once each afternoon. My first encounter with him was some ten days after I commenced work. I had precipitated some heavy metals from a solution with sulfuretted hydrogen, had filtered off the sulfides and was washing them out when I was aware of some one behind watching me. It was the *Bergrath*. He asked me with a smile what I was doing and, when I had told him, he wanted to know if the precipitation was complete. Before I could answer he had taken a whiff of the filtrate and from a bottle of sulfuretted hydrogen water standing on my desk had poured into the beaker a lot of the reagent. A heavy black precipitate formed instantly. "You see," he said, "the precipitation was not complete. Hereafter, when you have occasion to throw out of a solution a substance, see to it that the proper reagent is added *in moderate excess*." I was too mortified to reply, and I am still mortified, although my stupidity was perhaps pardonable. I had never before worked in a laboratory, and had no conception of the many details to be observed. Although from the beginning polite and helpful, it was only toward the end of my course in qualitative analysis that he commenced to show me marked attention. I had reported to his assistant that a complicated mixture contained, along with ten or twelve other substances, zinc; but, according to him, no zinc was present. I repeated my work and again found zinc. It

separated from the alkaline filtrate from manganous hydroxide, after the former had been acidified with acetic acid and treated with sulfuretted hydrogen. The amount of zinc sulfide found was small, but before the blowpipe it gave all the characteristic reactions for zinc. In some way I got it into my head that the caustic potash was responsible for my mistake, and sure enough a solution of three or four grams of the alkali, acidified with acetic acid and treated with sulfuretted hydrogen, gave me zinc sulfide. Winkler happened to appear just as I finished making the blank test, and I told him the caustic contained zinc. He shook his head, but listened politely to my account of what I had done, and asked me for a piece of the potash. Next day he informed me I was right, and that he had written the manufacturer to account for the presence in it of the zinc. "I never before," said he, "heard of such a thing as zinc in caustic potash." It turned out that the lye had been evaporated in galvanized iron kettles.

He had accepted the reforms recommended by Cannizzaro, and in his lectures taught the unitary conception of the constitution of compounds, and always employed the revised nomenclature and symbolism. And yet in ordinary conversation he was apt to use the dualistic terms of Lavoisier and Berzelius. "Remove the excess of acid with a solution of carbonate of soda," he said to me one day, and when I had the nerve to ask him if his language was correct, he vouchsafed this reply: "When a student I learned to say carbonate of soda and speak of a solution of carbonate of soda. Now we are told we must say sodium carbonate and speak of a solution of sodium carbonate. No telling what terms they'll use when you are as old as I am." To say truth, isn't one term nowadays as expressive as the other? A few years ago an eminent chemist who read the manuscript of one of my papers objected to my use of the word blue vitriol. Juliet's remark: "What's in a name? That which we call a rose, by any other name would smell as sweet" seems very apropos in regard to this matter.

Winkler was a skilled mineralogist and deeply interested in the phenomenon of isomorphism, but any attempt to account for seemingly foreign elements in crystals by assuming that they replaced some of the main constituents, when the former and latter were totally unlike *chemically*, he wouldn't tolerate. Only once did he call me down and that was when, in connection with some work of mine, I suggested the possible isomorphism of arsenic and sulfur. The idea wasn't mine but that of some prominent German mineralogists. I told him so, but it only served to provoke him the more. His sole comment was, "*Reiner Blödsinn!*"

In my examination of the cobalt, nickel, and iron pyrites, already referred to, which contained much arsenic, the precipitation of the latter with sulfuretted hydrogen from a solution containing it in the higher state of oxidation gave me no end of trouble. I told the *Bergrath* that Wacken-

roder, Ludwig, and Rose's explanation couldn't be correct, for the precipitate wasn't a mechanical mixture of the trisulfide and sulfur, but one containing the pentasulfide as well. "Since," I said, "the pentasulfide is always present, as Fuchs has shown, how are we to account for its formation?" "The interaction of arsenic acid and sulfuretted hydrogen," he replied, "is, and always has been, one of the mysteries of analytical chemistry. I have sometimes imagined that during the interaction an acid analogous to sulfurous or hyposulfurous acid is generated, and yet I cannot see how such a compound could be formed, much less exist, in the presence of the hydrochloric or sulfuric acid present." That remark sank deep in my subliminal consciousness, and only welled up years later, after I became an assistant in the Princeton laboratory. It led to the discovery of the three sulfoxyarsenic acids, whose instability and decomposition products furnish us with a perfectly rational explanation of the formation of the mixture of the two sulfides and sulfur when sulfuretted hydrogen acts on solutions of arsenic acid. Otto Brunck, his successor, was discussing with him the fact that in electrochemical analysis the adhering character of some metals, such as bismuth and zinc, is markedly improved by increasing the number of slits or holes in the Fresenius cone. "Since such is the case," said Winkler, with a laugh, "the ideal cathode should be one composed entirely of holes." So he took a piece of platinum gauze of very fine mesh, fashioned it into a cylinder, attached to it a piece of stout platinum wire, and gave us the electrode which bears his name. From my standpoint it is the best, cheapest, and most practical of the platinum electrodes.

Winkler was the pioneer in the field of technical gas analysis. His work on the subject was published in Freiberg, the first part in 1876, the second in 1877. The book was the outcome of years of experimental work in various parts of the mining country of Saxony, where, before his appointment at Freiberg, he had been devising schemes for condensing the sulfur dioxide gas, formed during the roasting of sulfur ores, which was causing havoc with the vegetation. There were at the time but few rapid methods for analyzing air containing this gas, as well as the gaseous mixtures from all sorts of retorts, furnaces, etc., so quick and reliable methods had to be worked out. The gasometric methods of Bunsen in their original form, were too refined and tedious for such purposes and had to be modified. While using his original gas buret in making a determination of carbon dioxide and oxygen in a flue gas I was much struck by one of the glass stopcocks it carried. Winkler informed me that the glass-blower who made his first buret insisted that no such cock was possible, and that the man worked for months before the difficulties were overcome. I refer, of course, to the three-way stopcock, now so well known, and, curiously enough, often called the Geissler cock, although Geissler had nothing to

do with its invention. Mention should also be made of his ingenious little absorption coils which we used for trapping water and carbon dioxide in our combustion analyses.

He gave me an account of how, in his younger days, he proposed to get rid of the sulfur dioxide from a large ultramarine factory by leading the gas into nitrosulfonic acid, now called nitrosylsulfuric acid, thereby transforming it into sulfuric acid, and how this idea led him to his investigation of the changes which occur in the Gay-Lussac towers, a piece of work which, when published, attracted wide attention, not only in the industrial field, but in that of pure chemistry as well. Indeed, from this time on he never lost sight of the problem of converting sulfur dioxide into sulfuric acid without the intervention of the lead chambers, a problem which he ultimately succeeded in solving, and in a most brilliant manner. In 1875, two years after his appointment to the chair of chemistry in Freiberg, Winkler published in *Dingler's polytechnisches Journal* a short article in which he states that by using a reaction discovered as early as 1831 by Peregrine Phillips, an Englishman, and employing purest oxygen and sulfur dioxide in stoichiometrical proportions, he had been able to prepare in his laboratory sulfuric anhydride in relatively large amounts, and in the same communication he sketches a small plant in which he suggests that effort be made to manufacture the compound on an industrial scale. Pure sulfur dioxide and oxygen in the correct proportion may be obtained, he tells us, by dropping concentrated sulfuric acid on red-hot quartz fragments (a method recommended by Deville and Debray for preparing oxygen gas), and removing the water formed by condensing it for the most part, and then forcing the gases through concentrated sulfuric acid. This famous article created a sensation! "It acted," says George Lunge, "like the wand of the magician on a world of banished spirits." The demand for sulfur trioxide, or concentrated sulfuric acid highly charged with it (oleum), was then great, owing to the development of the coal-tar dye industry; so in numerous localities attempts were made to manufacture the anhydride according to Winkler's proposal, but with indifferent success. Winkler continued his study of the reaction, and so impressed the management of the Royal Smelting Works with its significance that a small building was erected in which he was permitted to continue his investigations. This was in 1876. He did not patent his process but gave it to the Saxon government, hence the extraordinary secrecy in which everything bearing on it was shrouded. In 1878 he informed the management that he had succeeded in preparing the anhydride from kiln and furnace gases; so a new and larger building with the proper equipment was installed, and before the end of 1879 a continuous and goodly amount of the anhydride was being manufactured.

Kiln gases containing from 7 to $7\frac{1}{2}$ per cent of sulfur dioxide by volume

were employed, but the yields were small, only 45–50 per cent of the sulfur dioxide being converted into sulfuric anhydride, the unconverted portion being sent into the lead chambers. It having occurred to Winkler to pass this unconverted portion through another contact tube, he found to his surprise that from 97 to 98 per cent of the dioxide in the original kiln gas had been transformed into sulfuric anhydride; so a kiln gas of about 6 per cent sulfur dioxide by volume and containing a considerable excess of atmospheric oxygen was employed, and toward the end of the eighties the Freiberg works were turning out daily as much as 1200 kilos of the anhydride per unit furnace. In the development of the process great difficulty was experienced in purifying these kiln gases, for dust and the merest traces of arsenic were found to paralyze the activity of the contact mass, but the problem was gradually solved, and from the year 1881 on the gases entering the contact tubes were so pure that the activity of the platinum remained unchanged for years. The platinized asbestos employed during the early stages of the process was replaced in 1883 by platinized pumice and this discarded in 1888 for platinized unglazed porcelain. He found that the best temperature for effecting the union of sulfur dioxide and oxygen was in the neighborhood of 450°C. The anhydride was absorbed in concentrated sulfuric acid. While taking my practical course at the smelting works I used to see the anhydride plant every day, and while I knew what the sort of work was that was going on in it, for I had seen Winkler's elaborate lecture-room experiment for demonstrating the preparation of sulfuric anhydride, of the details I had not the faintest conception. I didn't even know that kiln gases were being used. The secret was kept inviolable for twenty-five years.

Die Badische Anilin- und Soda-Fabrik commenced to work on the same problem, the preparation of sulfuric anhydride from kiln gas, in 1881. Their chemist, Rudolf Knietsch, after 15 years of ceaseless toil, succeeded in overcoming all obstacles, and, in the early nineties, the company had in operation an anhydride plant of such size and efficiency that the old lead chamber system was discarded. Since all the devices for purifying the kiln gases, applying the mass law, constructing and cooling the contact tubes and absorbing the anhydride in concentrated sulfuric acid were patented, Knietsch, in his famous address in 1901, was permitted by the company to make his process known to the entire world. This magnificent work of Rudolph Knietsch was characterized by Winkler himself as "*weltbewegend.*" I have dwelt somewhat in detail on this matter to prove that it was Clemens Winkler and not Rudolf Knietsch who first made the contact process for manufacturing sulfuric anhydride a commercial success. His process antedates that of Knietsch by fully twenty years. This process is, from my standpoint, Winkler's greatest contribution to industrial chemistry, while that to pure chemistry is his discovery of the element germa-

nium. In 1885 Weisbach ran across a new and exceedingly rare mineral from one of the Freiberg mines which he called argyrodite. Winkler analyzed it, but found his analysis to be about 7 per cent too low. This discrepancy he showed later was due to a hitherto unknown element. In a long letter which I received from him in 1886 he gave me a full account of his work, so far as he had then carried it, and subsequently I received from him letters or reprints setting forth his further work on the subject. It was over four months before he succeeded in obtaining it, or rather in preparing a pure compound from which he could isolate it. Brunck tells us that from the very beginning, Winkler was convinced the argyrodite was a sulfo-salt of silver and contained a new element—one analogous in its analytical behavior to arsenic, antimony, and tin, but, although a master in the art of analysis, it was only through ceaseless toil by day and night that he succeeded in trapping it. When the mineral was fused with sodium carbonate and sulfur, the melt treated with water, the residue filtered off and the arsenic and antimony precipitated as sulfides by *slightly* acidifying the filtrate with hydrochloric acid, a solution was obtained in which the element *had* to be present, for the various precipitates obtained certainly did not contain it. And yet a further addition of acid produced no change. He repeated the work again and again without any success. Finally, on February 6, 1886, since a moderate amount of free acid, as in all previous cases, caused no change, he added it to his filtrate recklessly and in great excess when suddenly to his astonishment a white precipitate formed which, on stirring the solution, became flocky and settled rapidly. This precipitate proved to be soluble in ammonia water and could be thrown out of the solution again on the addition of a large excess of the acid. It turned out to be the sulfide of the unknown element. This, oxidized and heated in a current of hydrogen, was transformed into a gray, metallic powder which, fused at a high temperature under borax, yielded lustrous, iron-gray globules—the ekasilicon of Mendeléeff, which Winkler named germanium. Think of a sulfide which possesses the unique property of being insoluble in strong acids but soluble in dilute acids and water! No wonder Winkler experienced such difficulty in obtaining it. From this stage on all was easy. We can understand the delight he experienced in finding that his results, as he obtained them, were in almost exact agreement with the predictions made twenty-five years before by Mendeléeff. Sir Henry Roscoe states in his Bunsen Memorial Address that germanium was isolated by the application of spectrum analysis!

Winkler begged me to make a study of pentathionic acid, the existence of which had been recently questioned by Spring of Liège. "Spring's statement," he remarked, "strikes me as strange, for in the regeneration of sulfur from soda residues I have stood in front of tanks containing immense quantities of pentathionic acid." He came to my desk once loaded down

with jars, bottles, and cardboard boxes containing raw and refined thallium and a number of its salts prepared from flue dust obtained in the roasting of Meggener pyrite. "I have been asked by the management of the Aussig Soda Works," he said, "to report on this material, but I haven't the time, and would be glad to have you undertake the work." I had to refuse both the former and latter investigations, for I was up to my eyes in work. To say truth, I was overdoing things, did break down, and was a very ill man for a long time. Please remember that I was not specializing in chemistry, but studying to become a mining and metallurgical engineer.

I have known no eminent man who enjoyed more a "*geselliger Abend*" than did Winkler. Frau Winkler was well aware of this fact and would occasionally compel him to give a dinner to some of his favorite pupils. The last one at which I was present, shortly before leaving Freiberg, was more a banquet than a dinner. At each man's place stood a liter bottle of wine of some celebrated vintage, which the guest was expected to empty. Full dress was about the only formality. The *Bergrath* sat at one end of the table, his breast covered with decorations, while Frau Winkler sat at the other. The lovely Fräulein Winkler, the prettiest girl in Freiberg, along with other women, were scattered around so as to cheer up the shy, and convince them that life was worth living. The *Bergrath* kept his eyes on us, and when he noticed any one shirking his wine he would sing out, "You're not drinking," and, springing to his feet, with a bottle of the precious brew in his hand, would rush to the culprit's chair and fill up his glass. He kept us hilarious with a line of stories about prominent men he knew, or had known, Frau Winkler all the time begging him to desist, and his beautiful little daughter shaking with laughter and observing *sotto voce*, "*Ach, Papa, wie kannst du den armen Mann so misshandeln.*" After dinner we had music. Winkler was a good musician and played several instruments. In the midst of the slow movement from one of de Beriot's violin concertos, which a student was playing, there was a terrific crash outside. Frau Winkler asked her spouse to investigate. He left the room, but returned in a few minutes with a broad grin on his face. "*Meine Herrschaften,*" he exclaimed, "*das Dienstmädel ist besoffen.*" I was somewhat shocked, but since all, men as well as women, laughed uproariously, I too joined in the hilarity. I had been taught that when one goes to Rome one should do as the Romans do.

Many were the efforts made to get Winkler away from Freiberg. Between the years 1878 and 1902 he was called to the Polytechnicum in Dresden, to the University of Leipzig, to the famous Technische Hochschule at Charlottenburg, and finally to the University of Göttingen. He declined all these calls. True, he was eager to accept the last, for he was to build and equip a laboratory according to his own ideas, and do nothing but carry on his investigations in inorganic chemistry and supervise those of a

number of clever and promising young men who had already taken their doctor's degrees, but his health had begun to fail, and, realizing that he could never live to make the new institute a success, he felt compelled to decline the invitation. He died a few years later, in October, 1904, in his 66th year.

Before leaving Freiberg Winkler advised me to go to Heidelberg and carry out some silicate analyses under Bunsen's[4] directions. He gave me a letter of recommendation to the famous chemist, and Stelzner gave me one to the geologist, Rosenbusch, whose course on microscopical petrography was at this time said to be the best in Germany.

I arrived in Heidelberg early in April, 1882. Bunsen was absent so I called on Professor Rosenbusch who received me in a most affable manner, and assigned me a place in his private working room. I was introduced to his two assistants, both of whom became famous geologists, and a favorite pupil, Mr. George H. Williams, who, on his return to the United States, was appointed professor of geology in The Johns Hopkins University. Williams and I became intimate friends and remained such until his death in 1894. When I told him I proposed doing silicate work under Bunsen's direction he handed me two specimens of quartz porphyry from the Black Forest, which he requested me to analyze for him, as his inaugural dissertation for his doctor's degree had to do with rocks from this district. I used to spend an entire day each week in Rosenbusch's laboratory. I kept on the *qui vive*, however, all the time, and as soon as I heard that Bunsen had returned I hastened to his office and knocked. Hearing the word "*Herein*" I entered, clicked my heels together, in true German military fashion, made a profound bow, and handed over my letter from Winkler. Bunsen was standing and had, of course, a cigar in his mouth. While he was reading the letter I sized him up carefully. He was a splendid looking man, fully six feet in height, and built like Hercules. Although over seventy years of age he had lots of hair. My remembrance is that it was practically white. He was clean shaven, barring the lower front of his neck, which was covered with what, in my boyhood, was vulgarly known as a "Cardiff ruff." I knew he had lost the use of his right eye owing to an explosion of cacodyl cyanide, but I could detect no evidences of the tragedy. I never saw a more cheerful and engaging face. It seemed to breathe all that is good, great, and best. As he read a smile appeared, and when he had finished he let the letter fall on the floor and held out his hands to me. "I understood," he said, "that you were coming, and I asked one of my assistants to reserve a desk for you." After inquiring about some of the Freibergers, and assuring me that he approved of my desire to analyze the quartz porphyries, he wanted to know whether I

[4] See "Robert Wilhelm Bunsen," by R. E. Oesper, THIS JOURNAL, **4**, 431–9 (Apr., 1927).

was familiar with his flame reactions. My reply was that, although I had been well drilled in blowpipe analysis, I didn't know much about his flame reactions. He then told me to get a copy of his pamphlet and go through the work carefully. "I'm confident," he added, "that when you have mastered the tests you'll never again use a blowpipe." I was informed later that he insisted on all his students making these flame tests.

ROBERT WILHELM BUNSEN, 1811–1899

He lectured every day at 8 A.M. His lectures were not as complete, nor as detailed, as Winkler's, but they were admirably adapted for giving the beginner a good idea of the fundamental facts and principles of inorganic chemistry. With hypotheses and theories he had little patience. He seemed to be influenced solely by facts and laws. He used to insist that one irrefragable and important fact was worth an ocean of theories. He employed the Berzelius symbolism and dualistic nomenclature. Unlike Berzelius, however, a symbol as well as a formula stood for an equivalent. Our acid anhydrides he called acids, our basic anhydrides, bases. His consistent use of the system of equivalents in his lecture room, as well as in his laboratory, will give you a better idea of his indifference to the atomic and molecular theories than any other evidence I could submit to you. He rebuked me once for using atomic weights in making a calculation. "Use equivalents," he said, "they are far simpler."

Among his lecture-room experiments there were two which impressed me deeply. He told us that while iron, cobalt, and nickel were attracted by a magnet at ordinary temperatures, at high temperatures this property was characteristic of cobalt only. To prove his statement he hung little bars of the three metals in the flames of three burners, so that each bar was

bathed on all sides by the flame. When the temperature was sufficiently high, he brought a powerful magnet near the cobalt and it immediately moved out of the flame, while the iron and nickel were not affected by the approach of the magnet.

After giving us a detailed account of nitrogen trichloride he proceeded to prepare from chlorine and a solution of ammonium chloride, and in a simple piece of apparatus, a few drops of this capricious and highly unstable compound. The yellow drops were trapped in a small lead dish under the ammonium chloride solution. After carefully removing the dish with a pair of tongs he placed it on the end of his table and touched one of the drops with a feather moistened with turpentine and tied on the end of a fishing rod about 20 feet long. A report like a clap of thunder, and the water in the dish was thrown clear to the ceiling! He worked during the entire experiment with the utmost nonchalance, and appeared to be delighted at the excessive nervousness displayed by most of the men in the front row, whose faces were as white as the drifted snow. Being in those days an over-sensitive little chap I did not feel very chipper myself, seeing that the Geheimrat had, just before picking up the fishing rod, informed us that the French chemist Dulong lost an eye and three fingers in preparing the compound.

In his lectures he spoke of practically all his famous discoveries. His references to the cacodyl compounds, his study of the Iceland geysers, his ice calorimeter, his rubber valve, his zinc-carbon battery, his photochemical investigations, his explanation of the color of the air of the Blue Grotto, etc., were received with rounds of applause, but the morning he told us he would devote the hour to an account of "the so-called spectrum analysis" the demonstration on the part of the students was tempestuous in its intensity. During the outburst he stood behind his lecture-room table as rigid as a statue, with his head bowed, and as if lost in contemplation, but the instant the noise ceased he resumed his lecture, and that, too, as if nothing had happened. He never once, in talking about his own work, used the personal pronoun I. It was always one did this, one did that. To other investigators, however, he invariably gave due credit for their discoveries. His private room opened directly into the large student laboratory, and he was constantly moving about among the men in whom he was interested, giving them advice and showing them how to manipulate. To the loafers he was indifferent; indeed, like Winkler, he seemed to ignore them.

I spent over two weeks on the flame reactions. He showed me a number of them not mentioned in his pamphlet, the most beautiful of these being a method for detecting traces of manganese in the presence of large amounts of cobalt. In a mixture of the sulfides of arsenic, antimony, and tin, the sulfide of tin being present in but tiny amounts, he showed me how, after the mixture had been roasted, the presence of tin and the other metals could

be readily recognized in less than six minutes. These flame reactions are so simple, rapid, and accurate that I cannot understand why they are not more widely employed. I've used them off and on for nearly 50 years, and am just as enthusiastic about them as I was in 1882. In analyzing the porphyries I became familiar with a number of tricks and dodges which have proved invaluable in my quantitative examination of minerals and rocks. Let me call your attention to one of them, a simple device which he called "*klatschen*." The filter paper carrying a sticky, amorphous precipitate is opened up, the unstained part cut away and the rest placed, precipitate-side down, in a dish or casserole. The paper is then pressed gently with the fingers so that all parts of the precipitate are brought in close contact with the porcelain. On catching hold of the edge of the paper we can peel it off, fully 99 per cent of the precipitate remaining in the dish. The tiny bit on the paper can then be quickly dissolved in a few drops of warm, dilute hydrochloric acid. The trick is especially convenient when we have occasion to remove a mixture of ferric and aluminum hydroxides from a paper prior to dissolving it. He had marked respect for any student having a big thumb, especially if the end of the thumb were over-developed. "That's a splendid thumb for gas analysis," he would exclaim. He handled hot objects with the utmost indifference. I've seen him lift with his thumb and forefinger the lid of a glowing porcelain crucible to examine its contents. One day, after showing me how to prepare a hard glass tube in which I was going to decompose some porphyry powder with strong sulfuric acid at a high temperature, he handed me the tube. To take the tube it was necessary to grasp it by the end which he had just removed from the blast flame. I naturally demurred, whereupon he turned the tube around, took hold of it by the well-nigh glowing end and carried it over to my desk. Roscoe says that when Bunsen was blowing glass one could sometimes actually smell him, so pronounced was the odor of burnt flesh. One of his assistants informed me that he (Bunsen) was so interested in the Leidenfrost phenomenon that once, after washing one of his hands thoroughly with soap and water, and then wiping it slightly, he plunged it into a pot of molten slag, without suffering any inconvenience.

All the pure reagents I needed in my work, such as caustic potash, silver nitrate, or platinum chloride, he made me prepare myself. While carrying on my regular work I used to amuse myself by making qualitative analyses of all sorts of complex minerals. When I told him I had found boric acid in a tourmaline, he wanted to know if I had obtained a perfectly satisfactory reaction for boron, and when I intimated I was making some check tests so as to be morally sure I was right he asked me to follow him. He led me down a corridor, unlocked a door and ushered me into a room not much larger than a public telephone booth. It contained a stool and little table and on this latter were a burner and a small, rusty, and dilapi-

dated looking spectroscope. He sat down, lit the gas, made a few adjustments, told me to bring some of my material into the flame, took a look, and then asked me to do likewise. There was no difficulty in recognizing the spectrum of boron. "That's one of the original spectroscopes," he said, "it is small, but it has always given perfectly satisfactory results."

An assistant called my attention to an ancient balance in the students' balance room. "It belongs to the old man," he said, "and isn't it a sorry looking object? See the long crack in the glass door. He could have the finest balance that human skill can contrive, but he insists he can weigh on this thing down to the twentieth of a milligram, and that suffices."

One of the sights of Heidelberg was Bunsen and Kopp (the author of the great work on the history of chemistry) strolling together down the Anlage, the former a veritable Goliath, the latter a little runt of a man. Some waggish student, skilled in the art of caricature, drew a picture of the two savants out for a walk. It was photographed, and in great demand in my day.

Endless stories have been told about Bunsen. Some of them are true, some have a basis of truth and some have been grossly exaggerated, or are apocryphal.

In 1881, the year before I went to Heidelberg, a number of his most famous pupils presented to him a bronze statuette of Berzelius, and a congratulatory address on the occasion of the celebration of the jubilee of his doctorate. Such a dread had he of public functions, especially of such as involved his presence, that on the day set for the event he, along with a few of his intimates, left Heidelberg stealthily and secreted themselves in a tavern in Gugenheim on the Bergstrasse. In case of Roscoe's arrival he noted the locality of his retirement on a card, which he sent to Mrs. Kopp, with the request that she hand it to him.

A very attractive and brilliant woman, having heard some wonderful accounts of Bunsen, came to Heidelberg just to see him and, curiously enough, put up at the Grand Hotel where, being a bachelor, he was accustomed to take his meals. At the *table d'hôte* she noticed directly opposite her a big, handsome man, with a well-knit figure, who seemed to be in a fit of abstraction and, O horror, had on no cravat. She recognized him at once and, leaning forward, murmured in her softest and most bewitching voice: "Excuse me, Sir, but you have lost your cravat." "That's not true!" he replied, as he put his thumb and forefinger in his waistcoat pocket and drew out a shabby little butterfly tie, which he held up triumphantly so that all could see it.

The following story always appealed to me. I can't vouch for its truth, but it gives us an admirable idea of Bunsen's zeal for accuracy. Some beryllium hydroxide which he had obtained in a quantitative analysis of the mineral beryl he had filtered off and washed out thoroughly. While the

water pump was sucking it as dry as possible he walked off to attend to something else. On his return he was dismayed to find that a fly had settled on the edge of the filter paper, and, finding the precipitate sweet, had sunk his proboscis deep into the amorphous mass and was devouring it voraciously. He made a grab for the insect which, of course, escaped. Then began a chase. An assistant and some students hearing the rumpus in the Geheimrat's room rushed in, and, when they learned the cause of the trouble, joined in the chase. The fly was finally captured by a student, who handed it over to the great man. He killed it by crushing it between his thumb and forefinger, taking care, however, to avoid touching the end of the proboscis to which a due modicum of beryllium hydroxide was still sticking. After igniting the little carcass in a platinum crucible, at first gently, then intensely, so as to destroy every trace of organic matter, he moistened the residue with a drop of hydrochloric acid, and from the resulting solution recovered a tenth or so of a milligram of beryllium oxide. This was added to the weight of the oxide got by glowing the original hydroxide and an excellent result obtained. If there be any professors who would impress upon the minds of their pupils the possibility of obtaining flawless, analytical results in circumstances over which we seem to have no control, let them tell the story of Bunsen and the fly.

Bunsen retired in 1889, and died on August 16th of that year at the ripe age of 88, one of the greatest of the scientific giants of the nineteenth century. He was not only a chemist but a physicist as well. Some, indeed, go so far as to call him the first of the physical chemists. He used to say that a chemist who is no physicist is nothing. While indifferent to hypotheses and theories he did much to establish the evidence on which our modern theories rest.

It was my privilege in my youth to study under the direction of a number of eminent men, but none of them so stimulated and inspired me as did Winkler and Bunsen. Of the former I may say: He was a staunch friend, an ideal teacher, and a great investigator.

> "Take him for all in all,
> We shall not look upon his like again"—

of the latter:

> "His life was gentle and the elements
> So mixed in him, that Nature might stand up
> And say to all the world: *This was a man.*"

A university has no doctrine to teach. Its special purpose is to investigate what is true in any field. It is the special gift of the great teacher to open the mind of the pupil.—*Jermiah W. Jones*

AN INSPIRING COURSE IN INTRODUCTORY CHEMISTRY

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It is the belief of the author that a teacher of high-school chemistry should be able to originate and develop a course in appreciative chemistry that will truly inspire every student; that no textbook ever written can do this for him; that any good modern text may be used as a base. Such a course, succeeding admirably, is here outlined.

Originality the Key Note

Since symbols are the chemist's shorthand, they are learned thoroughly the first day (*i. e.*, symbols of the common elements). A short history of chemistry is given by the teacher, followed by an inspirational lecture. The course for the year is outlined to the students. Then comes work, hard, intensive, satisfying work: a study is made of the atom and its structure and properties, of the molecule, gas laws, valence, formulas, equations, chemical calculations. All this in the first two weeks. Then comes the reward: a chemistry club is organized—"Protons" is the name this year—a reporter is elected, a play committee is named, programs are arranged.

From now on every week or ten days is a unit, with all the study wrapped around the life of a famous chemist, often contemporary. First was Joseph Priestley week. We lectured and studied about carbon dioxide; we experimented with it in the laboratory; we had a Joseph Priestley program.

The program was interesting, talked about all over school. Carbon dioxide became romantic; Joseph Priestley is loved. The paper about the man who had originated carbonated beverages told of a preacher who dared to think, was persecuted, burned out of house and home, chased from his native England, sought refuge in our own state of Pennsylvania, loved chemistry, did experiments while making sermons, was influential in organizing the great American Chemical Society, discovered oxygen, made soft drinks.

No less appreciated was the paper which told of dry ice, the use of carbon dioxide in the treatment of insane people, in fire extinguishers, in the manufacture of baking and washing sodas, in baking, in soft drinks. One of the group of five conducting the program gave a demonstration with a bottle of ginger ale and a tube of lime water, with dry ice and tap water, equations being written on the board. Another explained a display showing how sodas are made from limestone and salt, how pop is manufactured from coal and flavored water, sweetened. An instructive and attractively decorated poster giving the number of pounds of carbon dioxide used annually in the United States in the making of sodas and soft drinks was exhibited. Three minutes were assigned the teacher for a carbon dioxide "pep" talk. The class was then treated to pop, donated by a local manu-

facturer of soft drinks, and blotters bearing a soft drink advertisement were distributed to all.

Next came Antoine Lavoisier week and oxygen; Alfred Nobel week and nitrogen; Irving Langmuir week and hydrogen; Edward Goodrich Acheson week and carbon (lubricants). A full week was devoted to the study of the atom. Though there were many men about whom we might have woven that week's work, we finally chose Theodore William Richards.

One week Svante August Arrhenius dominated our classroom, his name in bright letters, with the single word IONS beneath, greeting us from the blackboard each morning as we entered. The boys, Group III, had a good program. One had made a model atom, grotesquely magnified, clipped off the rotating electrons, leaving an ion. Another had made a model cell for the electrolysis of sodium chloride. A third did electroplating, then reversed the poles and removed the plate. He also compared the strength of acetic and hydrochloric acid by passing an electric current through solutions of each, in series with a light. The poster picturing the industries dependent on electrolytic dissociation, portraying Arrhenius, was good, as were also several papers prepared on pertinent subjects.

The name of Herman Frasch displaced that of Arrhenius. At the program invisible pictures were painted in a most visible manner by precipitating sulfides; a rubber display was exhibited; papers read; a new poster of brilliant hue displayed; and the moving picture on "The Story of Sulfur" was shown. (To finish paying for the moving picture machine evening movie programs were given.) Other activities of the week included a day of discussion, a moving picture on rubber, a day in the laboratory preparing sulfur in its various forms, and a day of demonstration.

Our next unit will require more time, as it is desired to study sulfuric, hydrochloric, and nitric acid together. Our inspiration will come from the work and life of Sir William Henry Perkins. Lending color to the program will be a paper on dyes. In the meantime we will enjoy a trip, by movie, "Through the Oil Fields of Mexico;" we will recall "The Modern Hercules" (dynamite) shown when we studied nitrogen. It will be a thrilling study, what with adventurous laboratory work, novel demonstrations, interesting discussions. Oh yes, we also take trips to near-by industrial plants. The Cracking Plant will fit in nicely, since we live in Titusville, the scene of the first oil well ever drilled.

So it goes. We will find time for a few simple unknowns at the end of the year. The course is inspirational because the lives of the chemists are an inspiration in themselves; it is rational because the course is presented in organized units; it is successful because the student's interest is aroused the first day and never allowed to die down. Originality, that much sought-after element, is given full opportunity to develop. Each group arranges its own program, under guidance of the instructor. Each man appears

before his class five times in the year, with his original contribution. He is once chairman of a meeting, and that meeting has to "go over."

Character a Requisite to Success

At the very beginning we agree that a strong character is one of the essentials to success, that we are more interested in developing character even than we are in learning chemistry. To that end mutual trust and coöperation is pledged. Since the purpose of tests is to help the student to check up on his progress, each frequently corrects his own paper, using the system outlined by the instructor. The teacher may not even ask the grade. Bad marks are, nevertheless, taken to heart, extra effort resulting. Notebooks are turned in but once a term. In the laboratory each student lists his own breakage in a common book conveniently placed. The instructor emphasizes the need of listing for the interest of all concerned all articles immediately as they are broken. Thus no injustice is done, no police attitude is required. Breakage bills are easily collected at the end of the year. In practice it works here.

Laboratory efficiency, attitude, neatness, offerings at programs are easily checked. Laboratory experiments over, every desk is left scrupulously clean, lockers in order. Discussions before and after laboratory work prove very beneficial. Notebooks are for the students, not for the teacher. Undue stress is not laid upon them. No student deceives himself with the idea that a super notebook is going to pass him in chemistry. Neat notebooks are, however, kept. Keen observation, clear reasoning, easily noted during discussions, are at a premium, exalted, set up on a pedestal to be worshiped. Grades are never mentioned. "Square play," on an equal footing, is demanded as much of the teacher as of the student.

Helps Available

Most of the popular, modern books on chemistry, physics, and biology are included in the classroom science library. A good school library, containing sets of the latest editions of the best encyclopedias, is available for our use. An excellent public library is also at our disposal. A notebook compiled by the author under the direction of Dr. G. W. Bennett of Grove City College, containing brief biographies of some hundred contemporary, American and foreign, famous chemists is a valuable asset. Harrow's "Eminent Chemists of Our Time" is worth its weight in gold.

A light, large, airy, freshly painted laboratory lends inspiration. Good equipment is a blessing enjoyed. Though the design of the room is not the most modern, it is such that convenience and lack of confusion are obtained. Bottles of reagents are not left on the desks, only the chemicals to be used in a given experiment being available on that day. This seems to

be not only the most convenient but the most sane method for a high-school laboratory.

The lecture room, with its banked seats, is equipped with a Micropticon, a 16-mm. moving picture machine, a large demonstration table, and display cases. Finally, and more important than all else, the closest coöperation is enjoyed between the superintendent, principal, chemistry teacher, and students.

Academic Home Study. In the April issue of the *Modern Language Journal* notice was taken of an announcement by a self-assembled number of commercial correspondence schools which conduct their ventures for commercial profit. Editorial comment suggested that this announcement paid no attention "to the extension or correspondence divisions of regular academic institutions." This comment seems to have given a wrong impression. To clarify the misunderstanding, additional explanation is due Extension Divisions.

The regular academic institutions will not permit themselves to be associated in any way with these commercial ventures. The extension work of universities, like all education, is organized to promote enlightenment, to advance intellectual interest and understanding, and to further the spirit of learning—not business profit. Nor does this imply any reflection upon any commercial incentives for profit—for that is of the nature of business, not education.

For an entire generation, the University of Chicago has conducted home-study courses, and for almost a quarter of a century the University of Wisconsin has carried on a program of even broader and more inclusive scope, in that vocational as well as academic instruction has been included. The home-study bulletins of these universities, as well as those of some forty other universities of the highest academic standards which are associated together in the National University Extension Association, are universally available.

It will be of interest to make note here of the fact that at the present time a national survey or study of correspondence-study instruction compared with residence teaching is being conducted by the University of Chicago, with the coöperation of the national member institutions throughout the country. This is, of course, a study of correspondence-study teaching as conducted in universities of known and accepted standards, and, again, will make no account of the great number of exploiting commercial ventures that take advantage of a contemporary educational development. Records of thousands of students, whose home-study and campus-study achievements stand side by side, are being studied and are furnishing remarkably illuminating results.—W. H. LIGHTY, *Director of Extension Teaching, University of Wisconsin*

Copper Won from Ore by Electrolysis. Small miners can now recover for the first time practically pure copper directly from sulfide ores by a method just discovered after a year's research by the school of mines and geology at Washington State College. The method requires cheap hydroelectric power. Present methods of recovering copper ore involve smelting, and electrolysis is used only to refine the metal. Only one previous attempt, made some 15 years ago, at obtaining practically pure copper directly from the ore by electrolysis was found in the historical researches undertaken. The details of the method will be published by the college.—*Science Service*

CHEMISTRY IN PUBLIC JUNIOR COLLEGES

STANLEY W. MORSE, STATE TEACHERS' COLLEGE, SAN FRANCISCO, CALIFORNIA

Students of chemical education should be interested in the place of the junior college in this field. Studies by F. L. Whitney[1] of 15 public and 15 private junior colleges were the only ones available.[2] It was the author's pleasure to make a preliminary study of this nature under Dr. W. C. Eells at Stanford University during the past summer and since then to expand the study to cover practically one-half of the public junior colleges of the United States. The results of these studies are presented in this paper.

Secretary D. S. Campbell of the American Association of Junior Colleges reports 126 "public" junior colleges in the September, 1928, "Directory of Junior Colleges." For the purposes of this study a "public" junior college is interpreted as one under the control of the local board of education. State- or university-controlled colleges are not included. In Table I is shown the distribution of the 126 colleges and the number from each state included in this study.

TABLE I

DISTRIBUTION OF PUBLIC JUNIOR COLLEGES IN THE UNITED STATES INCLUDING THE SAMPLING FOR THIS STUDY

From 1928 "Directory of Junior Colleges"

State	*Number*	*Sample*	*State*	*Number*	*Sample*
Arizona	1	1	Michigan	6	3
Arkansas	2	0	Minnesota	7	4
California	31	16	Mississippi	4	2
Florida	1	1	Missouri	7	4
Georgia	2	0	Nebraska	1	1
Illinois	5	3	Ohio	1	0
Iowa	20	9	Oklahoma	6	2
Kansas	10	5	Pennsylvania	1	0
Louisiana	3	1	Texas	15	8
Massachusetts	1	0	Washington	2	1
			TOTAL	126	61

The approach to the problem was to determine from the current bulletins (1928–29 or 1929–30) of the colleges the nature of the chemistry offered and the training and duties of the instructors. Bulletins were available for some 80 or 90 public junior colleges, but in order to obtain truly national representative data it was deemed best to consider as nearly as possible one-half of the colleges in each state. Selection within each state was based upon the enrolments obtained from the directory. Because of the two distinct types of junior colleges in California the sampling within this state

[1] "The Junior College in America," F. L. Whitney, Colorado Teachers' College Education Series No. 5, Greeley, Colo., **1928,** 258 pp.

[2] See also "Status of the Junior College in the Educational World," by L. V. Koos, THIS JOURNAL, **7,** 184–6 (Jan., 1930).

was made from each type separately on the same basis as in other states. The district type and high-school departmental type were equally distributed so that eight of each have been included. The colleges listed from Ohio and Pennsylvania were found to be controlled by universities, while one from Louisiana was found to have been discontinued. Sixty-one of the remaining 123 public junior colleges were then selected. The enrolment distribution of these schools is given in Table II. The approximate median and mean enrolments of the 60 cases given were 115 and 239, respectively.

TABLE II

ENROLMENT IN 61 PUBLIC JUNIOR COLLEGES, 1926–27

From 1928 "Directory of Junior Colleges"

Enrolment	*Number colleges*	*Enrolment*	*Number colleges*
20	2	301–325	0
21–50	8	326–350	1
51–75	8	351–375	2
76–100	4	376–400	1
101–125	12	.....	...
126–150	4	600	1
151–175	2	750	1
176–200	1	1131	1
201–225	3	1508	1
226–250	1	3014	1
251–275	3	.....	...
276–300	2	Not given*	2

* The 1928–29 *Bulletin* of one of these gave the 1927–28 enrolment as 59.

It can reasonably be said that the enrolment figures (for 1926–27) are too low to be representative of the colleges for which the bulletins were published. However, they are the latest available except in a few cases in which enrolment was published in the bulletin. Two cases serve to illustrate. One college listed as 277 gave the 1927–28 enrolment as 326 and a second listed as 107 in the Directory gave 164 as the 1928–29 value. It can fairly be assumed that enrolment changes are similar and that the relative values have remained approximately the same.

Nature of the Chemistry Offered

Of the 61 junior colleges studied, 60 (98.4%) included chemistry in the curriculum, one of these alternating a ten-unit first-year course with a similar course in physics. The college not offering chemistry was a one-year institution until 1928 when it was changed to a two-year. The median unit value of chemistry offered was 16.5 semester units, the mean value 18.2 and the range 6 to 44. In Table III is presented the distribution of these units among the 61 colleges.

TABLE III

TOTAL NUMBER OF SEMESTER UNITS OF CHEMISTRY IN 61 PUBLIC JUNIOR COLLEGES OF THE UNITED STATES (1929)

Semester hours	*Number colleges*	*Semester hours*	*Number colleges*	*Semester hours*	*Number colleges*
0	1	16	7	29	1
6	1	17	1	30	1
8	5	18	1	32–34	1
10	10	20	3	35	1
11	1	22	3	36	1
12	3	24	4	39	1
13	1	25	4	40	1
14	2	26	2	44	1
15	3	27	1		
				Total	61

Further observation showed:

17 (28.3%) of the 60 colleges offering a one-year course only.
7 (11.7%) offering a year and a half sequence.
22 (36.7%) offering two years in sequence.
14 (23.3%) offering a sequence of more than two years.

Colleges offering 6, 8, and 10 units belonged to the first class as did one of the 16-unit colleges. This listed two courses of 8 units each, with and without high-school prerequisite. The 11-unit college presented work equivalent to the 10-unit courses divided into a year of general (8 units) and a semester (3 units) of qualitative analysis. The other of the year and a half schools followed the general first-year work with a semester of quantitative analysis or organic chemistry, 4 and 2 schools, respectively.

Consideration of the offerings without reference to the length of the course or sequence shows:

17 colleges offering First-Year Chemistry only.
1 college offering General Inorganic and Qualitative.
12 colleges offering First-Year Chemistry and Organic.
10 colleges offering First-Year Chemistry and Quantitative Analysis.
18 colleges offering First-Year Chemistry and Quantitative Analysis, and Organic Chemistry.
1 college offering First-Year Chemistry, Quantitative Analysis, and Organic for Home Economics, etc.
1 college offering First-Year Chemistry, Quantitative Analysis, and Biological Chemistry.

Some of the above schools offered additional courses. Further data on the nature of the courses are presented in Table IV. The wide variety of special offerings to meet local needs, actual or university, determined, indicates the possibilities present when the size of the school permits.

TABLE IV

CHEMISTRY COURSES AS OFFERED IN 60 PUBLIC JUNIOR COLLEGES OF THE UNITED STATES

Data from *Bulletins* available in 1929

Nature of courses	*Number of courses*	*Semester hours*			*Division of units*			
		Total	*Mean*	*Range*	*Lect.*	*Lab.*	*Not speci.*	*Lect. / Lab.*
General Inorganic no prerequisites	18	143	7.9	4–12	78	53	12	1.47
General (Qual. later) with prerequisites	15	116	7.7	3–10	57	39	20	1.46
General and Qualitative	39	359	9.2	6–11	197	139	23	1.42
General Inorganic Qual. not listed	4	28	7.0	6–8	18	10	..	1.80
Qualitative Analysis separate course	16	59	3.7	3–5	15	22–24	21	0.65
Quantitative Analysis*	30	146	4.9	3–8	44	71	31	0.62
Organic Chemistry	30	166⅔	5.5	3–10	88	48⅔	30	1.81
General for Engineers	3	16	5.3	5–6	7	4	5	1.75
General and Qual. for Home Economics, Physical Education or Nurses	3	21	7.0	3–10	11	10	..	1.10
Adv. Qualitative Anal.	1	3⅓	...	..	1⅓	2	..	0.66
Special or Adv. Quant.	2	9	4.5	4–5	2	2	5	1.00
Adv. Organic	1	2	...	..	2	....	..	..
Organic for Home Econ.	1	4	...	..	....	....	4	..
Household Chemistry	2	6	3.0	3	4	2	..	2.00
Sanitary Chemistry	1	3	...	..	2	1	..	2.00
Elem. Physical Chem.	2	8	4.0	3–5	6	2	..	3.00
Agricultural Chemistry	1	4	...	..	1	3	..	0.33
Biological Chemistry	1	2	...	..	1	1	..	1.00
Industrial Engineering Chemistry	1	3	...	..	3	....	..	
Engineering Materials	2	6	3.0	3	6	...	..	..
Plant Power Chemistry	1	2	...	..	2	....	..	..
Principles of Inorganic	1	2	...	..	2	....	..	..
Mineralogy*	1	4	...	..	2	2	..	1.00

* Does not include a course listed in a bulletin without unit value.

General Chemistry without Prerequisites.—Four of the eighteen courses without prerequisites were one semester in length, seemingly preparatory to the regular first-year course. One of four units preceded an eight-unit general chemistry, two of five units preceded three- and five-unit general courses, respectively, qualitative analysis following in a separate course in each case. Another five-unit beginning chemistry preceded a ten-unit, including qualitative arrangement.

The remaining fourteen beginning courses continued throughout the year. Two were six units, five were eight units, six were ten, and one was twelve units in length. One of the six, three of the eight, one of the ten and the twelve unit courses were followed by qualitative analysis in a separate course. Four of the ten unit courses included qualitative analysis. The

other six-unit, two of the eight-unit, and the remaining ten-unit course made no provision for the qualitative except in the regular first-year course having a high-school prerequisite. It is hoped that most of these courses are complete in themselves and not preparatory for other general chemistries.

Two colleges did offer general chemistry without prerequisite as the only first-year course. Advanced work followed these beginning courses.

Laboratory Provisions.—The more standard courses, general inorganic, qualitative and quantitative analysis, and organic chemistry were examined for the nature of the laboratory work. Ratios of lecture to laboratory units indicated a satisfactory laboratory time allotment for the types of chemistry offered (see Table IV), except perhaps for quantitative analysis.

Other trends in the time required for laboratory work were shown by the data presented in Table V.

TABLE V

LABORATORY HOURS REQUIRED FOR A UNIT CREDIT IN 60 PUBLIC JUNIOR COLLEGES (1929)

	GENERAL INORGANIC		QUALITATIVE ANALYSIS		QUANTITATIVE ANALYSIS		ORGANIC CHEMISTRY	
Lab. hr. per unit	*Number courses*	*%*	*Number courses*	*%*	*Number courses*	*%*	*Number courses*	*%*
6 hr.	2	2.6	..	...	..	...	2	6.7
4 hr.	5	6.6	1	6.2	..	...	1	3.3
3 hr.	36	47.4	6	37.5	20	66.7	16	53.3
$2^2/_3$ hr.	..	...	..	...	1	3.3	..	...
$2^1/_2$ hr.	1	1.3	..	...	..	...	..	...
2 hr.	19	25.0	4	25.0	2	6.7	2	6.7
No lab.	..	...	..	...	..	...	3	10.0
Hr. not specified	13	17.1	5	31.3	7	23.3	6	20.0
TOTALS	76	100.0	16	100.0	30	100.0	30	100.0

The three-hour laboratory unit was most common (approximately 50% of the cases) in all types of chemistry, the two-hour unit running second. Most of the courses recorded as not specified stated that laboratory work was included but did not state the time division. In these studies the hour value of a unit was found by dividing the number of hours per week by the unit value, *e. g.*, a course described as, "5 units, three hours lecture recitation and six hours laboratory" was recorded as 3 units lecture and 2 units laboratory with a three-hour unit value. Three two-hour periods per week for two units were recorded as three-hour laboratory units.

The four- and six-hour laboratory units were in Texas colleges. A typical quotation indicates that there can be no doubt of the accuracy of these data as unusual as they may seem:

"Three lectures and six hours laboratory a week, 4 semester units."

In the case of organic chemistry three courses (10%) were definitely lecture courses, no laboratory being offered in organic in those colleges. Two of

these courses were four units, the third six units in value. One other college offered a three-unit lecture course followed by a second three units, divided as one lecture and two laboratory.

Duplication of First-Year Chemistry.—Data on the duplication of general inorganic courses in a college to meet different needs are outlined below.

2 courses, with and without prerequisite	12 colleges	20.0%
2 courses, regular course and a special for engineers	2 colleges	3.3%
2 courses, regular course and special for home economics, physical education, nurses, etc.	2 colleges	3.3%
TOTAL colleges offering 2 courses in general inorganic chemistry	16 colleges	26.6%
3 courses, beginning, regular, and a special for engineers	1 college	1.7%
3 courses, beginning, regular, and a special for home economics, physical education, etc.	1 college	1.7%
4 courses (meeting and recorded as 3). With and without prerequisites for general purposes and also for engineers	1 college	1.7%
TOTAL number colleges offering more than one general inorganic chemistry course	19 colleges	31.7%
	Of the 60 colleges	

Allied Subjects.—To properly consider the functioning of the junior college in chemical education, offerings in allied subjects must be given some consideration. The fields of physics, mathematics, French, and German are those more often required of chemistry students. A brief study was made of these fields in the 60 public junior colleges offering courses in chemistry.

Mathematical and French opportunities were found fairly adequate. Physics was not so well provided for, 36.7% of the colleges not offering the subject. German was not offered in 55% (33) of the colleges. Table VI contains data on the distribution of physics and mathematics and the

TABLE VI

LOWER DIVISIONS OFFERINGS IN FIELDS ALLIED WITH CHEMISTRY IN SIXTY PUBLIC JUNIOR COLLEGES OF THE UNITED STATES (1929)

Subjects	*Colleges not offering*		*Colleges offering*	
	Number	%	Number	%
French	3	5.0	57	95.0
German	33	55.0	27*	45.0
Mathematics	0	0.0	60	100.0
Through Analytical Geometry only	..	..	10	16.7
Through Differential Calculus only	..	..	2	3.3
Through Integral Calculus or more	..	..	48	80.0
Physics	22	36.7	38	63.3
From 6 to 10 units	..	..	25	41.7
More 10 in sequence	..	..	13	21.6

* One course offered if a sufficient number apply.

number of schools offering the foreign languages. Generally if a language was offered it covered four semesters or more of work, including beginning courses. Six schools offered scientific German and two presented scientific French.

The Chemistry Instructor

The bulletins of the 60 colleges providing chemical instruction were examined to determine the number of chemistry instructors, their degrees, and other administrative or instructional duties.

Number of Instructors.—As naturally expected, most of the junior colleges, 47 (78.3%) had one instructor in chemistry. Eight schools (13.3%) had two chemistry instructors, three others had three, four, and eight instructors, respectively, while two colleges did not report the instructors in the bulletins. The total number of instructors reported was 78 in 58 colleges.

Degrees of Instructors.—Degrees were not listed for ten of the 78 instructors, 8 of the unlisted being from one college. Of the 68 whose degrees were given, 51 (75.0%) were holders of a Master's degree while all but 6 (8.8%) showed evidence of post-graduate work. Details of the degrees are given below (Table VII).

TABLE VII

TRAINING OF CHEMISTRY INSTRUCTORS IN 60 PUBLIC JUNIOR COLLEGES (1929)

Bachelor's degree only	6 or 8.8% or the 68 instructors
Bachelor's degree and graduate	6 or 8.8%
B.S. and B.Pd.	1 or 1.5%
B.M.E., A.C. and graduate	1 or 1.5%
Master's degrees*	51 or 75%
Ch.E.	1 or 1.5%
Ph.D.	2 or 2.9%
TOTAL	68—100.0%

* Includes one Ph.M. in chemistry.

Instructing or Administrative Duties

Since many of the junior colleges are affiliated with high schools it is to be expected that instructors should teach in both the college and high school. High-school duties are not reported in this study.

Fifty (64.1%) of the 78 instructors worked in chemistry alone. The most common combination was chemistry and the biological sciences (biology, zoölogy, or botany) claiming six instructors. Chemistry combined with mathematics, physics, administration, or bacteriology was found in more than one case each. Chemistry with geology and with athletics as well as a number of triple combinations occurred once each. Definite data for three instructors could not be determined from the bulletins. An outline of the combinations found is given below (Table VIII).

TABLE VIII

DUTIES OF CHEMISTRY INSTRUCTORS IN 60 PUBLIC JUNIOR COLLEGES (1929)

*Nature of duties**	*Number instructors*	*%*
Chemistry only	50	64.1
Chemistry and biological science	6	7.7
Chemistry and mathematics	4	5.1
Chemistry and physics	3	3.8
Chemistry and administration	3	3.8
Chemistry and bacteriology	2	2.6
Chemistry and athletics	1	1.3
Chemistry and geology	1	1.3
Chemistry, physics, and mathematics	1	1.3
Chemistry, physics, and athletics	1	1.3
Chemistry, physics, and biological science	1	1.3
Chemistry, administration, and biological science	1	1.3
Chemistry, administration, and geology	1	1.3
Not definitely defined in bulletin	3	3.8
TOTALS	78	100.0%

* May be part-time high school.

Summary

(1)—61 junior colleges under the control of local Boards of Education have been selected from the 1928 Directory of Junior Colleges. The sampling was prorated as nearly as possible among the states of the United States and was selected by enrolment within each state.

(2)—A catalog study of chemistry instruction in these 61 junior colleges has been made.

(3)—98.4% of the colleges offered chemistry courses.

(4)—The median and mean number of units offered by a college were 16.5 and 18.2 units, respectively.

(5)—Data are presented on the sequence of courses and on the combination of courses offered by a college.

(6)—Studies of laboratory time allotments show them to be adequate for most of the chemistry offered.

(7)—The three-hour laboratory unit predominated in general inorganic, qualitative, and quantitative analysis and in organic chemistry.

(8)—Consideration of colleges offering more than one general chemistry course shows 19 colleges (31.7%) to be providing for special needs.

(9)—Of the usual allied fields required of a chemistry major, mathematics and French seem adequately provided for while physics and German were less frequently found.

(10)—The average chemistry instructor in these junior colleges would be the holder of a Master's degree, would be the only chemistry teacher in the school, and would probably teach chemistry only, perhaps with some high-school teaching or one other field in the smaller colleges.

List of Colleges Included in Study

ARIZONA: Phoenix Junior College.

CALIFORNIA: *District Type*—Fullerton, Marin, Modesto, Riverside, Sacramento, San Bernardino, San Mateo, Santa Rosa.

High-School Departmental Type—Central, Pomona, Porterville, San Benito, Salinas, Santa Maria, Taft, Ventura.

FLORIDA: St. Petersburg.

ILLINOIS: Crane (Chicago), Joliet, La Salle-Peru-Oglesby.

IOWA: Britt, Burlington, Cresco, Creston, Mason City, Sheldon, Tipton, Washington, Webster City.

KANSAS: Arkansas City, Coffeyville, Fort Scott, Garden City, Kansas City.

LOUISIANA: Southeastern Louisiana.

MICHIGAN: Bay City, Grand Rapids, Port Huron.

MINNESOTA: Eveleth, Itasca, Hibbings, Virginia.

MISSISSIPPI: Harrison-Stone-Jackson, Hinds.

MISSOURI: Kansas City, Jefferson City, Moberly, St. Joseph.

NEBRASKA: McCook.

OKLAHOMA: Muskogee, Northeastern.

TEXAS: Brownville, Clarendon, Edinburgh, Paris, Ranger, San Antonio, Texarkana, Wichita Falls.

WASHINGTON: Centralia.

TOTAL NUMBER—61

William H. Nichols. William H. Nichols, industrial chemist, banker, and educator, died of heart disease in Honolulu on February 21st. After supervising the opening of a new refinery in El Paso, Texas, for the Nichols Copper Co., of which he was president, Doctor Nichols visited his daughter at Coronado, Calif., and then sailed with his son for a vacation in Hawaii, where he died after an illness of two weeks.

For nearly sixty years Doctor Nichols had been prominent as a manufacturing chemist and copper refiner, establishing his own business in 1870, when just out of college. He was the founder of the General Chemical Co., chairman of the board of the Allied Chemical & Dye Corp., and at the time of his death still held many directorships. For many years he was a trustee and member of the council of New York University, and acted as chancellor for some months in 1929. He gave to the university the Nichols Chemistry Building which was dedicated in December, 1927, and contributed $250,000 last June for a new building for the school of education. It was through his generosity that the Nichols Medal was established in 1902, for the most outstanding contribution in any of the publications of the AMERICAN CHEMICAL SOCIETY, and to date twenty-two awards have been made.

He was a member of many chemical societies, a former president of the Society of Chemical Industry, and a founder and Past President of the AMERICAN CHEMICAL SOCIETY. A brief sketch of his career was printed as one of the series of American Contemporaries [*Ind. Eng. Chem.*, **15**, 424 (1923)]. More formal obituaries will be printed in the *Journal of the American Chemical Society* and in *Industrial and Engineering Chemistry.*—*Ind. Eng. Chem., News Ed.*

Coal in Morocco. The first two tons of coal won from Moroccan soil have reached Rabat from the Jerada basin.—*Chem. and Ind.*

VISUAL AIDS IN CHEMICAL EDUCATION

II.[1] The Program of the Committee on Visual Aids in Chemical Education with Reference to Exhibits

Exhibits held in connection with the meetings of the Division of Chemical Education of the American Chemical Society have proved their worth. The school exhibits at these meetings, for the greater part, have been projects as well as various types of work prepared by students for the instructor. In general, commercial exhibits have been designed with the idea of selling the products of the exhibitor. At the Columbus meeting, last spring, these types of exhibits were found in considerable numbers. For the Cincinnati[2] meeting the committee plans to present the various forms and aspects of visual aids in such a manner that every instructor can derive inspiration and definite help from them.

Too often the impression is prevalent that *visual aids* refer wholly to moving pictures and slides. As was indicated in the preceding article of this series[1] such devices do not begin to represent the scope of the term. For many schools, moving pictures and slides as regular classroom adjuncts for routine work may be impractical for the present. But there are available to all schools other types of visual material which involve a minimum expenditure of time, effort, and finance. Among these aids are to be found diagrams and charts of sufficient size to be visible from the front of the room. The "set up" of demonstration apparatus on any given unit of work also belongs to this class of visual material.

The exhibits as planned for the Cincinnati meeting should be of value to all teachers inasmuch as photographs of the exhibits will appear in the November or December issue of THIS JOURNAL.

The Committee has listed five questions below and would appreciate receiving answers from any teachers willing to coöperate. It is suggested that any diagram or chart material submitted be on paper or cloth of sufficient size to be seen across the ordinary classroom. Answers to the questions or material to be exhibited should be sent to M. V. MCGILL, Lakewood High School, Lakewood, Ohio. Announcement will be made later as to the place in Cincinnati to which material may be addressed.

1. Are you willing to coöperate in the preparation of visual aid material for the Cincinnati meeting of the A. C. S. (September, 1930)?
2. If you could be present, what visual aid material would you be interested in seeing?
3. Without going into the matter thoroughly at this time, please list some definite visual aid or aids, for the preparation of which you can be responsible.
4. Would you appreciate a suggested list of material from the Committee?

[1] See THIS JOURNAL, **7**, 828–33 (Apr., 1930).
[2] Cincinnati, Ohio, Sept. 8–12, 1930.

5. Can you suggest commercial sources where visual material (not the usual exhibit of products) has been secured at minimum or no cost?

For the Indianapolis[3] meeting, it is planned to feature the work of the students. Details concerning this type of exhibit will be found in the June (1929) issue of THIS JOURNAL.[4]

[3] Indianapolis, Indiana, April, 1931.

[4] THIS JOURNAL, **6**, 1153–5 (June, 1930).

Nitrided Nitralloy. Nitriding is the name applied to a process in which special steels are case hardened with ammonia gas instead of substances which introduce carbon into the surface of the steel (case-carburizing). Nitralloy is the trade name of special steels selected for use in the nitriding process because they show the maximum surface hardness when exposed to ammonia gas under definite conditions.

This product is of especial interest and represents a very important metallurgical development. In the regular case-carburizing processes temperatures of 1600 to 1700°F. are employed and the operation is often accompanied by more or less distortion. Subsequent heat treatment is necessary to harden and refine case and core. In the nitriding process, temperatures of only 900 to 1000°F. are used. Except in special cases the process is carried out at 950 to 975°F. It is obvious that there should be no distortion if machining and hardening strains have been removed. Furthermore, no further heat treatment is necessary after nitriding as this can be done previous to the operation itself. A case of maximum depth and ductility can be produced with a hardness superior to that of case-carburized material. In fact, at the sacrifice of some ductility a case can be produced having a Brinell hardness in excess of 1000. It will scratch glass. Testing files are worn smooth without affecting the hard surface. This hardness is retained to a remarkable extent at elevated temperatures.

Another important advantage for many purposes is the superior resistance to atmospheric, plain and salt water corrosion as compared with ordinary steel. The alloying constituents of Nitralloy give it toughness and high shock-resisting properties. It forges and machines satisfactorily in both the annealed and heat-treated condition. When nitrided it has been found in service to possess unusual wearing qualities. In the aviation industry, for instance, it has been found that during 100 hours' operation, nitrided cylinders showed no wear, whereas heat-treated steel cylinders showed a wear of 0.003 to 0.004 inch. Oil consumption in the heat-treated steel cylinder motor increased 300%, whereas it remained constant in the nitrided cylinder motor.

The applications of this product are too numerous to mention in their entirety. Following, however, are some of them: anvils, bushings, cams, chucks, clutches, cylinders, dies, gages, gears, steering mechanism, steam nozzles, pinions, wrist pins, rollers, spinning rings, cam shafts, crank shafts, pump shafts, and spindles.—*Ind. Bull.* of *Arthur D. Little, Inc.*

Philadelphia Chemical Club to Aid Students. The Chemical Club of Philadelphia is raising an amount sufficient to provide an income to bestow one or more annual prizes of $50 each to students in Philadelphia institutions of learning "to that student who, in the opinion of the faculty of the department of chemistry and chemical engineering, shows the greatest promise of future leadership in chemical industry."

Subscriptions to the endowment fund are now being taken, payable over a three-year period.—*Ind. Eng. Chem., News Edition*

CHEMISTRY CLUB WORK

H. F. Cope, Medford High School, Medford, Oregon

High-school teachers may be interested in a form of club work wherein parallel sections in chemistry may participate during school hours. In our department we have had successful club work during the last four years and this success may be attributable in a large measure to the fact that the programs are held during school hours and the content of the program is considered as a part of the regular work in chemistry.

Meetings are held about every six weeks during the school year in the science lecture room which accommodates sixty students. Two parallel sections take part in each meeting, one section having charge of the program while the other section is visiting. Some time previous to the meeting a chairman, program committee, ushers and a reporter are chosen to represent the section in charge of the program and these are expected to have full responsibility in making the proper arrangements for a successful meeting. The program committee, the chairman and the instructor of the section in charge of the work meet two or three times either before or after school hours and agree on what material to present and make assignments. After assignments have been made the program committee and the chairman see that the meeting follows as planned.

The entire program takes on the form of a review of the work in chemistry studied during the six-week period preceding the meeting. The work is usually presented under three heads, as follows: (*a*) demonstrations, (*b*) readings, (*c*) slides. For demonstrations some of the experiments in chemistry and physics may be presented; for readings usually some supplementary material not previously studied may be presented; for slides, sketches of set-ups and equipment, reactions, etc., may be presented. In choosing the material to be presented an effort is made to make the program not only interesting but exceptional to a certain extent. The entire program need not take longer than fifty minutes for presentation.

For those teachers who are interested in club work the first program as presented by our classes during the present school year will be given below:

TOPIC—WATER

(*The entire program borders on this subject inasmuch as the work in chemistry for the six-week period preceding the meeting covered this UNIT of study* as presented in Gordon's "Introductory Chemistry.")

Demonstration

Opening Number—**Spontaneous Combustion**—(To make this impressive the room was darkened, only two small colored bulbs in the front part of the room remaining lit. A wire frame mounted on a ringstand was used and the club's insignia—skull and cross bones—was outlined on it by means of a nitrated cotton string. Filter paper moistened

with a solution of phosphorus in carbon bisulfide was placed at the base of the support and connecting the string. Just about the time the curtain parted the image flashed.)

Reading

Poem—"The Brook"—(Any other poem might be selected.)

Demonstration

The Weight of a Liter of Water—(A liter measure, a counterpoise, a kilogram weight, a 1500-cc. vessel containing more than 1000 cc. of water required. The student counterpoised the liter measure, placed the kg. weight with the counterpoise and then added water from the larger vessel until the balance tipped. Interesting to chemistry students.)

Reading

"Water as an Element"—(This should involve some of the early history of chemistry when water was considered as an element.)

Demonstration

Ozonizing the Air—(A spark coil, glass tube with electrodes, a supply of oxygen in a large bottle, starch-KI paper for test required. An oxygen generator giving a steady supply of oxygen may be substituted for the supply of oxygen.)

Demonstration

The Specific Gravity of a Liquid—(The student used a specific gravity bottle and determined the specific gravity of mercury in the usual way. In order to speed up demonstrations they must be tried out by the students previous to the meeting.)

Reading

"The Tiniest Drop of Water"—(This would involve the water molecule, its composition, etc.)

Demonstrations

The Freezing Point of Water—(A test tube with a small amount of water, a thermometer, a mixture of salt and ice required.)

Introducing Mr. Deliquescent—(A student with hair dripping wet appeared before the audience, bowed, exit.)

Introducing Mr. Efflorescent—(A student with hair heavily powdered appeared before audience, etc.)

The Kipp Hydrogen Generator—(The student explained and demonstrated the action of the generator.)

The Oxy-Hydrogen Blowpipe—(A supply of oxygen and hydrogen necessary. Glass tubing, steel wool, etc., were heated in flame.)

Reading

"Water, the King of Solvents"—(The student lays emphasis on solubility of substances in water.)

Demonstration

The Filter Pump in Action—(A solution of common salt and one of silver nitrate were put together, the precipitate removed by using pump, filter flask, and funnel.)

Reading

"The Occurrence of Water"—(Water in different substances, forms, etc., was considered by the student.)

Demonstrations

A Mixture of Oxygen and Hydrogen—(Four boys and two girls formed a group of "molecules." One member spoke of the dangers attending such a mixture when at the same time a boy entered with a torch. Of course, an explosion followed. A small pistol and blanks were used.)

The Sodium Gun—(A hard glass test tube was half-full of water, a small piece of sodium attached to a fine wire placed in the top of the tube and the cork stopper inserted. A string attached to the tube allowed the student to lower it to the floor and tip over. The gas generated was sufficient to expel the cork. Caution must be used to protect the audience from the effects of any explosion that might break the tube.)

Boiling Water with Cold Water—(An ordinary flask filled with boiling water was stoppered, inverted, and cold water poured over the flask. This made the water boil.)

Hunting for Hydrogen and Oxygen—(A test-tube rack containing a dozen or more stoppered test tubes, some of them being placed in an inverted position. Two of the tubes contained the gases that the student was looking for. The two tubes, one of oxygen and the other of hydrogen, should be filled a short time previous to the time of demonstration.)

Building Fire with Cold Water—(Some sawdust mixed with sodium peroxide bursts into flame when water is dropped on the mixture. Use only small amounts of material.)

Slides

(Ordinary glass plates the size of picture slides were used. Diagrams of set-ups in laboratory, reactions, etc., were graphically illustrated by preparing the slides with white ink. An ordinary projection machine is required.)

Teachers will find that the material given above is largely suggestive and that splendid programs may be readily arranged in any school without making a special effort to duplicate the above demonstrations. Programs must be arranged to fit the equipment available. Chemistry students will take great interest in this type of work and they are eager to demonstrate if given an opportunity. Visiting classes benefit greatly by this work as student demonstration work with proper accompanying explanations will usually meet the demands of the audience.

Test Devised to Pick Talented School Teachers. The good teacher—the one who not only knows how to impart knowledge, but who is the living spirit of leadership and helpfulness and fairness and enthusiasm—can be picked out from untalented prospects by psychological methods, H. C. Almy and Herbert Sorenson, of the University of Minnesota, told educators attending the recent meetings at Des Moines, Iowa, of the American Association for the Advancement of Science.

Present methods of rating students in training to become teachers and methods of rating professional teachers in school systems vary widely, and many injustices are committed by those who evaluate teachers' work, the report declared. The new psychological rating scale described was pronounced not yet perfected, but it promises to provide a more reliable yardstick for measuring the teaching type of personality.

The rating scale consists of twenty desirable traits, including sympathy, patience, progressiveness, leadership, helpfulness, foresight, love for children, tact and enthusiasm, and fairness.—*Science Service*

THE USE OF AN APTITUDE TEST AS A BASIS FOR SECTIONING FRESHMAN COLLEGE CHEMISTRY STUDENTS

KENNETH L. BIRD, STANFORD UNIVERSITY, CALIFORNIA

It is often the practice in colleges and universities to disregard individual aptitudes and native abilities in so far that students of all possible promises of success are thrown together in the same general chemistry classes. Such haphazard grouping retards the advancement of the upper one-third of the class in a study for which they are by definition well fitted. At the same time it often proves disastrous for every student whose mental development fixes him in the lower one-third of the section. It is possible to avoid a very significant part of the inefficiency inherent in such a system.

Realizing the need for some scientific basis for grouping students in general chemistry, Dr. L. L. Carrick at North Dakota State College, in the fall of 1926, adopted the plan of requiring an aptitude test of every student enrolling in the course. The test used for the aptitude determination is the "Iowa Placement Examination—Chemistry Aptitude," constructed by G. D. Stoddard and J. Cornog under the direction of C. E. Seashore and G. M. Ruch. Using the grades made in this test as a basis, the students are divided into three groups (*A*, *B*, and *C*) and are accordingly assigned to classes where they will be associated only with others of their same general development.

The requirements of the course are identical for all three groups. The grouping affords the department head an opportunity to arrange the instructors' schedules so that each instructor can presumably get the greatest development from the sections he meets. The instructor in turn has the opportunity to introduce special teaching methods. The lecture method is not used in any section.

The figures upon which this report is based were taken from 2407 term enrolments during the author's service at North Dakota State College as acting head of the department of general and qualitative chemistry. Each of these enrolments represents a completed term's work with a grade given. No withdrawals of any nature are included.

Table I

APTITUDE GRADE	NUMBER OF STUDENTS	PERCENTAGE OF TOTAL	AVERAGE GRADE MADE IN COURSE
0–9	5	0.2	46.0
10–19	86	3.6	62.6
20–29	285	11.8	67.1
30–39	424	17.6	70.1
40–49	536	22.3	71.5
50–59	486	20.2	74.3
60–69	339	14.1	77.9
70–79	165	6.8	79.9
80–89	60	2.5	84.5
90–99	21	0.9	86.0

Table I gives the aptitude distribution as found and the average grade made in the course by students whose aptitudes fell in the listed divisions.

The following general statements are of interest in connection with Table I. The average grade received in the course by the 2407 enrolments was 72.9. All students with aptitudes below 10 failed. Half of the students with aptitudes between 10 and 20 failed. Thirty per cent of the students with aptitudes between 20 and 30 failed. No student with an aptitude of 80 or above failed in the course.

Tables II–XI, inclusive, reveal the final grade distribution under the separate aptitude divisions.

Table II

APTITUDE 0–9, 5 STUDENTS

Final grade	*Number*	*Per cent*
Failure	5	100

Table III

APTITUDE 10–19, 86 STUDENTS

Final grade	*Number*	*Per cent*
Failure	31	36.0
Condition	10	11.6
70–74	34	39.9
75–79	10	11.6
80–84	1	1.1
Above 84	0	0.0
Above 84	0	0.0

Table IV

APTITUDE 20–29, 285 STUDENTS

Final grade	*Number*	*Per cent*
Failure	60	21.1
Condition	24	8.4
70–74	130	45.6
70–74	13	45.6
75–79	42	14.7
80–84	23	8.1
85–89	4	1.4
90–94	2	0.7
95–99	0	0.0

Table V

APTITUDE 30–39, 424 STUDENTS

Final grade	*Number*	*Per cent*
Failure	60	14.2
Condition	32	7.5
70–74	177	41.7
75–79	80	18.9
80–84	43	10.1
85–89	25	5.9
90–94	5	1.2
95–99	2	0.5

Table VI

APTITUDE 40–49, 536 STUDENTS

Final grade	*Number*	*Per cent*
Failure	50	9.3
Condition	30	5.6
70–74	228	42.6
75–79	112	20.9
80–84	72	13.4
85–89	29	5.4
90–94	12	2.2
95–99	3	0.6

Table VII

APTITUDE 50–59, 486 STUDENTS

Final grade	*Number*	*Per cent*
Failure	28	5.8
Condition	23	4.7
70–74	170	34.9
75–79	100	20.6
80–84	90	18.5
85–89	46	9.5
90–94	28	5.8
95–99	1	0.2

Table VIII

APTITUDE 60–69, 339 STUDENTS

Final grade	*Number*	*Per cent*
Failure	13	3.8
Condition	10	3.0
70–74	87	25.7
75–79	65	19.2
80–84	6	18.9
85–89	51	15.0
90–94	38	11.2
95–99	11	3.2

Table IX

APTITUDE 70–79, 165 STUDENTS

Final grade	*Number*	*Per cent*
Failure	4	2.4
Condition	2	1.2
70–74	36	21.8
75–79	24	14.6
80–84	32	19.4
85–89	37	22.4
90–94	24	14.6
95–99	6	3.6

Table X

APTITUDE 80–89, 60 STUDENTS

Final grade	*Number*	*Per cent*
Failure	0	0.0
Condition	0	0.0
70–74	8	13.3
75–79	4	6.7
80–84	13	21.6
85–89	12	20.0
90–94	16	26.7
95–99	7	11.7

Table XI

APTITUDE 90–99, 21 STUDENTS

Final grade	*Number*	*Per cent*
Failure	0	0.0
Condition	0	0.0
70–74	1	4.8
75–79	2	9.5
80–84	4	19.0
85–89	6	28.6
90–94	7	33.3
95–99	1	4.8

The correlation between aptitude grades and final grades in the course is also shown by the block graph (Figure 1). *F* and *C* on the vertical scale

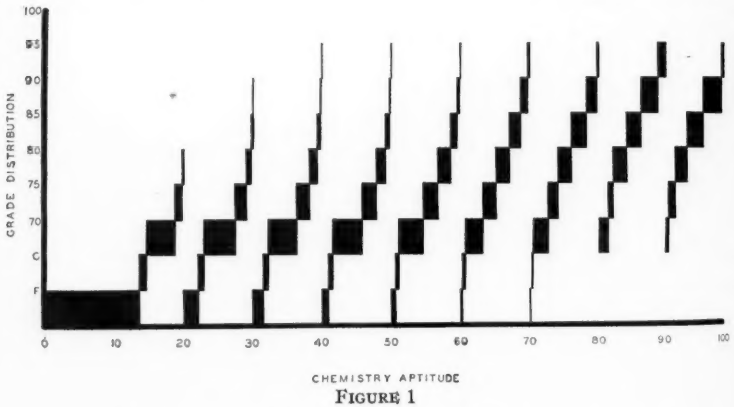


FIGURE 1

represent failure and condition, respectively. Blocks appearing above an interval of 10 on the horizontal scale represent the distribution of final grades for all aptitude grades within the interval. Numerous curves may be visualized from this chart. A slight inconsistency appears in the top horizontal row and also in the row fifth from the top. These are due to the fact that the number of enrolment figures available was not sufficient to give the true probability in every case.

When the aptitude grade is plotted against the average final grade in the course, the curve of normal expectancy is obtained (Figure 2). This curve shows what the average student trained in the territory from which

North Dakota State College draws its enrolment will do with the general chemistry course at that school. The curve has proved valuable in checking individual performances at various stages in the progress of the course.

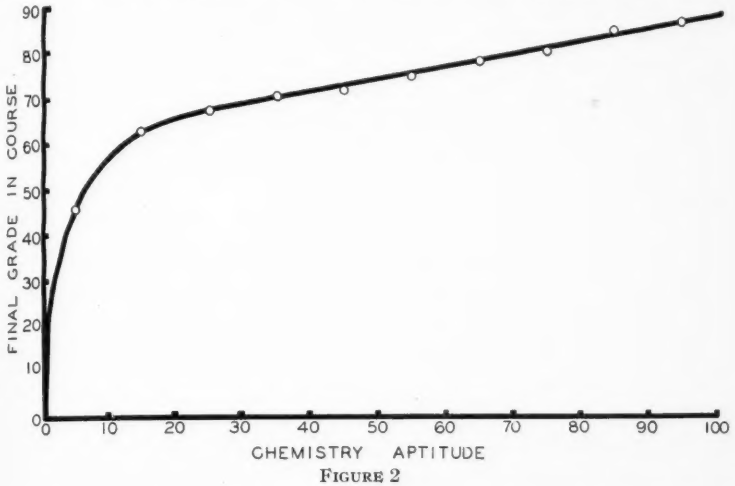


FIGURE 2

A similar curve for another school would vary in degree due to the local conditions.

The results of this study have demonstrated the value and possibilities in the use of an aptitude test in freshman college chemistry work.

Ozone in the Upper Atmosphere. As one may sleep warmly out of doors under a quilt, or shiver under a sheet, so the upper atmosphere, the stratosphere, is kept warm over arctic latitudes by a thicker layer of ozone. This was the explanation for a curious fact that has puzzled scientists, given before the American Meteorological Society by Dr. W. J. Humphreys of the U. S. Weather Bureau.

The stratosphere is the layer of the atmosphere above the highest clouds, and, unlike the lower layers, does not become colder with height. Temperature observations have been made of this layer by means of small balloons, equipped with recording thermometers. "They reveal the curious fact," said Dr. Humphreys, "that the stratosphere is coldest over equatorial regions and becomes gradually warmer with increase of latitude, the extreme difference being around 35 degrees Fahrenheit—coldest over the warmest earth and warmest over the coldest earth."

Though a full explanation has not yet been made, Dr. Humphreys thinks that it is due to the ozone. Observations have shown that there is less ozone over equatorial than over arctic regions, a fact that is itself yet unexplained. But the ozone absorbs radiation from the earth, and reradiates part of it back again. Therefore, where there is more ozone, more heat is sent back, and so the upper atmosphere there is warmest.—*Science*

NOTEBOOK METHODS IN HIGH-SCHOOL CHEMISTRY*

HOYT C. GRAHAM, NEW MEXICO STATE TEACHERS' COLLEGE, SILVER CITY, NEW MEXICO

During the school year 1928–29 the author of this paper made a survey to find what notebook methods are being used in chemistry classes in the best high schools in the United States. It was intended that the questionnaire should be sent to ten of the best high schools in each state in the United States. Since the author had no means of locating the best schools he sent the questionnaire to the largest high schools in each state. A few of the thinly populated states received less than ten questionnaires and a few states received more than ten.

The questionnaire was sent to the heads of the chemistry departments in 475 high schools. There were 351 or 73.89% returns. Among these 351 schools which returned the questionnaire the smallest enrolment was 115 and the largest 7500. The median enrolment was 873.2.

Of the entire 351 returns, nine schools were found which were not teaching chemistry. Therefore, the methods described in this paper are the methods used in 342 of our largest high-school systems.

QUESTION 1. *Do you require students to keep a notebook record of their laboratory work?* There were 308 replies to this question.

Notebooks required	287 or 93.2%
Notebooks not required	21 or 6.8%

QUESTION 2. *Do you require a loose-leaf notebook?*

Number of replies to question 2	297
Loose-leaf notebooks required	181 or 60.9%
Loose-leaf notebooks not required	116 or 39.1%

QUESTION 3. *Do you use notebooks with printed forms and questions in which students fill in blanks?* 332 replies were received.

Total using completion system	127 or 38.3%
Total not using completion system	205 or 61.7%

QUESTION 4. *Do you make the laboratory manual serve as a notebook by having the experiments written up on blank pages in the manual?* Only 19 reported that they are using this method.

QUESTION 5. *Do you require a formal notebook; that is, a notebook in which a definite outline is followed for each experiment, as follows: (1) Title of Experiment; (2) Materials and Apparatus; (3) Method of Procedure; (4) Results; (5) Discussion; (6) Conclusion?*

QUESTION 6. *Do you require only brief notes taken during the time the experiments are being performed, notes which state what was done and results*

* Reported before the New Mexico Association for the Advancement of Science at Albuquerque, New Mexico, October 31, 1929.

obtained? The papers considered for questions 5 and 6 were those which stated that the interlinear manual (question 3) was not used. 205 papers were considered and there were 200 replies.

Using formal notebooks	68 or 34.0%
Using brief notes	49 or 24.5%
Using combination of both methods	80 or 40.0%

Three stated that the "write-ups" consisted of answering definite questions.

QUESTION 7. *Are notebooks written in final form in the laboratory during the laboratory period?*

QUESTION 8. *Are notebooks written in final form outside of the regular laboratory period?*

Number of replies to questions 7 and 8	335
Notebooks written in laboratory	190 or 56.7%
Notebooks written outside of laboratory	119 or 35.5%
Using either method	26 or 7.8%

QUESTION 9. *Are students required to leave their notebooks in the laboratory between laboratory periods?* The papers considered for this question were those which stated that the notebooks were written in final form in the laboratory. The papers considered were 190 and there were 187 replies.

Notebooks required to be left in laboratory	149 or 79.7%
Notebooks not required to be left in laboratory	38 or 20.3%

QUESTION 10. *If notebooks are written in final form in the laboratory during the regular period, are the students permitted to take their notebooks home for study and review purposes?* There were 149 papers considered for this question and 144 replies obtained.

Notebooks permitted to be taken home	103 or 71.5%
Notebooks not permitted to be taken home	41 or 28.5%

QUESTION 11. *Do you require drawings in notebooks?* There were 333 replies. Drawings were required by 260 or 78.1% and not by 73 or 21.9%.

QUESTION 12. *Do you correct errors in notebooks?*

QUESTION 13. *If you do not correct errors do you indicate errors or corrections to be made?* Questions 12 and 13 received 305 replies.

Errors corrected	82 or 26.9%
Errors indicated	158 or 51.8%
Using combination of both methods	53 or 17.4%
Errors not corrected or indicated	9 or 2.9%
Notebooks corrected by students	3 or 0.9%

QUESTION 14. *How often do you collect notebooks?* There were 322 replies to this question. The six most commonly used time intervals are listed below:

When collected	No. of times reported
Collected at end of experiment or unit	65
Collected weekly	63
Left in laboratory corrected at any time	58
Daily	27
Monthly	26
Every six weeks	26
Every two weeks	14

No other one time interval was reported more than nine times. It is interesting to note that one instructor stated that the notebooks were collected only at the end of the course.

QUESTION 15. *Do you give a grade for the notebook?* There were 329 replies received.

Grades given for notebooks	251 or 76.3%
No grades given for notebooks	78 or 23.7%

QUESTION 16. *When, in your own teaching, did you adopt your present method of notebook procedure?* There were 254 replies.

Shortest length of time method has been used	0.25 year
Longest length of time method has been used	35.0 years
Median measure	4.2 years

The data show that the requirement of only brief notes is quite general. Of 332 chemistry teachers, 77% use some form of a brief-note system. From the many statements written on returned questionnaires the writer concludes that high-school chemistry teachers can obtain good results by having the students record, during laboratory periods, only such notes as the students themselves feel are necessary to study for tests and examinations which cover the laboratory work.

Incas Worked Largest Copper Mine. What is now the world's largest known copper ore deposit was worked by the prehistoric Incas, judging by remains that have been found at and near the copper mines of Chuquicamata, Chile.

Within the mine primitive tools have been found from time to time, such as stone hammers and wooden shovels, as well as mummified remains of early Indian miners, one of which is now at the American Museum of Natural History in New York.

The ruins of Pucaro, an ancient fortified city destroyed by the Spaniards during their first invasion of Chile, are 25 miles from Chuquicamata. Ancient graves belonging to this prehistoric city have yielded bowls and other utensils of copper as well as bead necklaces made from brochantite and atacamite, minerals characteristic of the Chuquicamata deposits.

The Incas, reputed as pre-Columbian, America's best miners and metal workers, conquered this part of Chile about 1443, it is reliably believed, and the old mines may therefore have been worked at least ninety years before the discovery of America.—*Science Service*

LABORATORY EXAMINATION IN GENERAL CHEMISTRY

R. K. STRONG, REED COLLEGE, PORTLAND, OREGON

For three years we have conducted a laboratory examination in the course in general chemistry at about the end of the third month. The method has been varied somewhat each year in the light of the experience gained. The great difficulty has been to set an examination that would be sufficiently easy for the student to execute and at the same time be a test of his ability. Since some of the students have one three-hour period of laboratory work per week and others have two such periods we have set separate examinations for each group.

Thus far we have found the following most satisfactory for the less advanced group.

Examination—Short Course

An unknown base, NaOH or KOH or NH_4OH, and an unknown acid, HCl or H_2SO_4 or HNO_3, will be given—200 ml. of each, about 3.0 normal. Make the largest possible recovery of dry salt after neutralization (litmus) and calculate the weight of salt remaining in the mother liquor. Both dry salt and mother liquor are to be submitted to the instructor in properly labeled bottles.

For the more advanced group we have varied the examination considerably each year. The method used this year proved more successful than previously. One week previous to the examination a copy of the following set of eleven problems was given to each eligible student (a few students not doing satisfactory work in the advanced course were given the elementary examination) and announcement was made that on the day of the examination *one* of the eleven problems would be assigned to *each* student, and he would be allowed two three-hour periods for the work.

Examination—Long Course

	Reaction	
I.	$CaSO_3$, 120 0.2 g. mol.	HCl.
II.	$BaCO_3$, 197 0.1 g. mol.	HNO_3.
III.	Fe, 56 0.2 g. mol.	H_2SO_4.
IV.	$(NH_4)_2SO_4$, 132 0.2 g. mol.	$Ca(OH)_2$. From CaO.
*V.	$MgCO_3$ (magnesite) heated. 84 0.03 g. mol.	Include determination of % ignited residue.
VI.	Air, 2 l. Displace by water.	Cu heated. (excess) Collect gas by displacement of water.
VII.	Air, 2 l. Displace by water.	C heated. (excess) Determination of % CO_2 in product.
*VIII.	PbO_2 heated. 239 0.03 g. mol.	Include determination of % ignited residue.
*IX.	CuO.	Determination of % composition.

*Use balance weighing to milligrams.

X.	City gas, 2 l. Displace by water.	CuO heated. (excess) Determination of % CO_2 in product.
XI.	H_2O, (excess)	Fe heated. 56 0.03 g. mol.

PRELIMINARY REPORT (In laboratory book)

1. *Title of laboratory test:*
   Note time begun.
2. *Materials:*
   (*a*) Name and formula (or known composition) of each.
   (*b*) Weights (or volume) to be taken
3. *Process:*
   (*a*) Equation, showing reaction weights (and volumes of gases).
   (*b*) Statement, by steps, of procedure to recover all products.
4. *Products:*
   (*a*) Name and formula (or composition) of expected substances.
   (*b*) Weights (or volumes) of same.
5. *Apparatus:*
   Sketch
6. *Present to instructor for examination.*

RECORD OF EXPERIMENT (Procedure followed; necessary additions to above; concurrent record)

1. *Assembly of materials and apparatus. Inspection* by instructor. Note time.
2. *Performance of experiment:*
   (*a*) Operations performed.
   (*b*) Quantities obtained.
   (*c*) Comparison with theoretical amounts.
   (*d*) Exhibit of products upon completion of work.

REPORT OF EXPERIMENT (On 3″ × 5″ card)

Title of laboratory test.
Materials taken, and amounts.
Products obtained, and amounts.
Other results, if any.
Yield: % of products compared with theoretical.
Date *Signature*

We purposely tried to select the more difficult problems for the better students, and conversely, so that each student was incited to do his best. The response on the part of the students was without exception excellent, both during the week of study and preparation and also during the examination. Furthermore, the opportunity to judge of the ability of students to plan an experiment and to carry out the same was considered valuable to the instructors. We feel confident that the results obtained justify the continued use of a laboratory examination, similar in type to the one described.

To Test Radioactive Waters. DR. LEWIS DILLON ROBERTS, of the department of chemistry of the University of Southern California, has been appointed to head the list of twelve men who have recently been recommended for the testing of radioactive waters by the U. S. Bureau of Standards. Others included in the list are H. SCHLUNDT of the University of Missouri; GEORGE B. FRANKFORTER of the school of chemistry of the University of Minnesota; E. E. BIEFER of the physics department of McGill University; ROLLA R. RAMSEY of Indiana University; D. H. KABAKJIAN of the University of Pennsylvania; H. N. MCCOY of Chicago, Illinois; S. C. LIND of the University of Minnesota; DR. BARKER of New York; A. F. KOVARIK of Yale University; and CHARLES F. WHITTEMORE of Chicago.—*Science*

THE DEGREE OF CHEMICAL ENGINEER AT CORNELL UNIVERSITY

For several years there has been a demand from the industries for men trained in Chemical Engineering. To meet this demand, the College of Engineering and the Department of Chemistry of the College of Arts and Sciences of Cornell University now offer jointly a curriculum leading to the degree of Chemical Engineer. This curriculum comprises five years of required and elective work. During the first four of these five years the student who expects ultimately to receive the degree of Chemical Engineer will be registered in the College of Arts and Sciences as a candidate for the degree of Bachelor of Chemistry, receiving that degree upon the completion of a definite four-year curriculum, the last two years of which contain a number of fundamental engineering subjects. During the fifth year of residence, the student will be registered in the College of Engineering as a candidate for the degree of Chemical Engineer and will receive that degree upon the satisfactory completion of this additional year of required and elective work. No student will be permitted to register for the degree of Chemical Engineer who has not completed the requirements for the degree of Bachelor of Chemistry or the full equivalent thereof, for years of observation and the testimony of our alumni in industrial positions has convinced the Department of Chemistry that broad and thorough training in the various fields of chemistry is absolutely indispensable to the full success of the chemical engineer in his professional practice.

At the present time there is a well-developed demand from the chemical industries not only for graduates in chemistry and chemical engineering but also for those who hold the degree of Doctor of Philosophy. It is our expectation that many of the students who complete the course in chemical engineering will decide to continue for the doctorate, just as do many of those now who graduate as Bachelors of Chemistry.

Inasmuch as the fifth year of study for the degree of Chemical Engineer is graduate in character, the Graduate School of Cornell University has ruled that this fifth year may be accepted as satisfying one year of the residence requirement for the degree of Doctor of Philosophy.

The student at Cornell University who wishes to prepare himself for the profession of chemistry may, therefore, receive the degree of Bachelor of Chemistry at the end of four years, the degree of Chemical Engineer at the end of a fifth year of study, and the degree of Doctor of Philosophy upon the completion of two further years of study and research. He may, of course, terminate his university residence at the end of the fourth year, or of the fifth year, or of the seventh year. There is demand in the chemical industries for all three groups of graduates. It should be borne in mind, however, that the training that the student acquires in the fifth year of study for the degree of Chemical Engineer is of great value for those

who seek positions that have to do with the development and supervision of the operation of industrial chemical processes and plants. The advanced work leading to the degree of Doctor of Philosophy constitutes admirable preparation for responsible industrial positions that involve research or the supervision of research, and many of the larger chemical industries now require that their appointees hold this degree. Most universities and larger colleges also restrict appointments to higher positions on their staffs to those who hold the degree of Doctor of Philosophy.

The two curricula leading to the degree of Bachelor of Chemistry, and the curriculum of the fifth year of study leading to the degree of Chemical Engineer are as follows.

The Degree of Bachelor of Chemistry

The degree of Bachelor of Chemistry will be awarded to those who have satisfactorily completed either of the following curricula, and the requirements prescribed by the University in Hygiene and Preventive Medicine and in Military Drill or in Physical Training. The completion of Curriculum No. 2, or its substantial equivalent, is required for admission to the fifth year of study leading to the degree of Chemical Engineer. Since the first two years of work are identical in the two curricula, the student is afforded ample time to discover whether his interests lie chiefly in the field of pure chemistry or in the field of chemical engineering before he is compelled to decide upon his further course of study.

CURRICULUM NO. 1

First Year

	Course	*First term*	*Second term*
Introductory Inorganic Chemistry	Chemistry 101	3	..
Inorganic Chemistry Laboratory	Chemistry 105	3	..
Introductory Qualitative Analysis	Chemistry 205	..	3
Qualitative Analysis Laboratory	Chemistry 206	..	3
Analytic Geometry and Calculus	Mathematics 5a, 7	5	5
Introductory Experimental Physics	Physics 3, 4	3	3
English	English 1	3	3
		17	17

Second Year

Introductory Organic Chemistry	Chemistry 305	3	3
Organic Chemistry Laboratory	Chemistry 310	3	3
Introductory Quantitative Analysis	Chemistry 220	3	..
Quantitative Analysis Laboratory	Chemistry 221	3	..
Introductory Chemical Spectroscopy	Chemistry 505	..	3
Gas and Fuel Analysis	Chemistry 250	..	4
General Physics	Physics 31, 32	2	2

	Course	First term	Second term
Physical Measurements	Physics 34	2	2
Drawing	Engineering 125	3	..
		19	17

Third Year

Introductory Physical Chemistry	Chemistry 405	3	3
Physical Chemistry Laboratory	Chemistry 410	3	3
Advanced Inorganic Chemistry	Chemistry 130	3	3
Introductory Chemical Microscopy	Chemistry 530	3	..
Advanced Quantitative Analysis	Chemistry 230	..	4
Elementary Mineralogy	Geology 311	3	..
Introduction to Economics	Economics 3	..	3
Elective		3	3
		18	19

Fourth Year

Introductory Industrial Chemistry	Chemistry 705	3	3
Seminary	Chemistry 905	..	1
Research for Seniors	Chemistry	4	4
Chemical Engineering	Chemistry 710	..	4
Electrical Engineering	Engineering 417	4	..
Elective	(at least)	6	6
		17	18

CURRICULUM NO. 2

(This curriculum is prerequisite to registration for the degree of Chemical Engineer.)

First Year

As in Curriculum No. 1

Second Year

As in Curriculum No. 1

Third Year

		First term	Second term
Introductory Physical Chemistry	Chemistry 405	3	3
Physical Chemistry Laboratory	Chemistry 410	3	3
Advanced Quantitative Analysis	Chemistry 230	4	..
Mechanics	Mechanics 330	6	.
Mechanics	Mechanics 331	..	5
Introductory Engineering	Engineering 103	1	..
Materials of Construction	Engineering 360	2	2
Introduction to Economics	Economics 3	..	3
Elementary Mineralogy	Geology 311	..	3
		19	19

Fourth Year

Introductory Industrial Chemistry	Chemistry 705	3	3
Industrial Organization	Engineering 380	..	2

		First term	Second term
Heat Engines and Auxiliaries	Engineering 341	3	3
Mechanical Laboratory	Engineering 368	3	..
Mechanical Laboratory	Engineering 369	..	3
Advanced Inorganic Chemistry	Chemistry 130	3	3
Introductory Chemical Microscopy	Chemistry 530	3	..
Research	Chemistry	4	4
		19	18

Candidates for the degree of Bachelor of Chemistry are required to take at least eight hours in research during the senior year in a division of the department to be selected by the student. These divisions are: Inorganic Chemistry, Analytical Chemistry, Organic Chemistry, Physical Chemistry, Optical Chemistry, Sanitary Chemistry, Industrial Chemistry, Agricultural Chemistry, and Biochemistry.

The elective courses required in the curriculum may be chosen by the student, in each case with the approval of the Department of Chemistry, from the advanced courses in chemistry, or from certain courses in other departments of the College of Arts and Sciences, or in other colleges of the University.

The Degree of Chemical Engineer

A holder of the degree of Bachelor of Chemistry who has completed Curriculum No. 2, as given above, may obtain the degree of Chemical Engineer, by completing a fifth year of study offered jointly by the College of Engineering and the Department of Chemistry of the College of Arts and Sciences. The curriculum for this fifth year leading to the degree of Chemical Engineer is as follows:

Fifth Year

	Course	First term	Second term
Electrical Engineering, Lectures	Engineering 415	3	..
Electrical Engineering, Lectures	Engineering 416	..	3
Electrical Engineering, Laboratory	Engineering 435	2	..
Electrical Engineering, Laboratory	Engineering 436	..	2
Mechanical Engineering, Laboratory	Engineering 372	2	..
Chemical Engineering, Laboratory	Chemistry 710	..	4
Machine Design	Engineering	3	..
Chemical Plant Design	Chemistry 730	3	3
Electives		5	5
		18	17

We need science in education, and much more of it than we now have, not primarily to train technicians for the industries which demand them, though that may be important, but much more to give everybody a little glimpse of the scientific mode of approach to life's problems.—*R. A. Millikan*

THE PREPARATION OF IODINE AND BROMINE SALTS BY THE EASIEST METHOD

ERNEST MACKENZIE MARSHALL, REDDING RIDGE, BETHEL, CONNECTICUT

The recovery of laboratory wastes is a worthwhile problem which should be tackled in its various aspects by every willing pupil. It gives the chance to do some real thinking, to purify a body of material from x impurities; a much more important discipline than the class analysis of mixtures where there are really no impurities. An article in the March issue of the JOURNAL[1] shows what can be done, but the method on the conversion into iodides can be greatly simplified.

If the quantity of iodine to be recovered is very small and there is no chlorine gas set-up, the latter can be dispensed with. Potassium chlorate to liberate the iodine is placed in a suitable flask or bottle, the necessary hydrochloric acid added, and then shaken with water, before adding the solution containing the iodine or the latter may replace the water. Chlorine water, if necessary, made in the same way completes the reaction, giving time for the decomposition of insoluble iodides.

Of course this is a crude way, not suitable if there are several gallons of liquor to work, but the method of preparing the chlorine water is a quick one if the small amount of resulting potassium chloride is of no importance. In fact it has been known to be made this way and sold to chemical laboratories.

The recovered iodine after slight washing is placed in a tall earthenware pot or other suitable vessel (a gas jar for small quantities) about twelve times the iodine volume, and desiccated calcium chloride added to take up water in the paste iodine. A perforated porcelain plate on a glass tripod rests above the iodine. The pot is covered with a sheet of glass, luted to the pot. For this class of work, almond or peach kernel meal, made from the cake after the oil is expressed, is mixed with water to a putty. It is particularly useful in making gas-tight apparatus where the joint is too large to be effected with the usual stopper or ring of rubber tube. It sticks wonderfully and is used largely in commercial distilling where the still heads are a loose sliding fit. Set the iodine pot in a tin pan with sand packed around it, but not up to the level of the iodine, and place on a radiator; or if the laboratory extends its bounds to include the steam boiler of the building, this is the best place. Over the week-end is the time for the sublimation. Cool well before opening. Some crystals will fall down, but the perforated plate will save them for use.

Much of "resublimed" iodine bought as pure is the crude product sublimed only once, and too quickly at that. Hence, as the article in the March issue of the JOURNAL[1] states, it tests only 95%, although the remaining 5% is chiefly water.

[1] Bonner and Masaki, "The Recovery of Iodine as Sodium Iodide from Waste Iodide Solutions," **7**, 616–7 (Mar., 1930).

Now what are we going to do with the iodine? Make *ferrous iodide.* Weigh the iodine and calculate the iron, using 5% in excess of the equation. Commercially pure iron wire, the fine wire found in the laboratory, is used. Place the iron in a suitable vessel, add ten times its weight of water and then add the iodine in small portions, no faster than enough to keep the liquid below 35°C.; otherwise iodine may be given off. As the solution becomes more concentrated, the reaction may be violent, so add the iodine more carefully. When the free iodine color is discharged, filter the green ferrous iodide and titrate a sample, if several iodides are to be made, otherwise the weight of iodine used gives the equivalent. Any soluble carbonate or hydrate will interact to form the corresponding iodide, with the complete precipitation of the iron.

Should one wish to make an insoluble iodide, such as mercuric iodide, it should be done through the sodium iodide. It is not feasible with the iron iodide to precipitate an insoluble iodide which will be free from iron. This whole process is an old and tried one for the commercial manufacture of potassium iodide. The soluble iodide produced by any method should be crystallized and the mother liquor reworked or used to precipitate an insoluble iodide.

Sodium iodide in the granular powder is best made by melting the large crystals in their water of crystallization in an enameled iron pan, with a handle, heated over a naked ring burner and stirred by a good fat glass rod. Gloves are good to have as the mass may spurt. Stirring faster is the cure. It is not difficult to produce a beautiful product with no iodide adhering to the dish. A bone spatula can be used to keep the dish free as the mass thickens. Do not stop, even for a second, is the only direction necessary to get a good result.

Deliquescent iodides, such as calcium iodide, are concentrated until the pellicle shoots across the surface of the hot melt. It is then poured on a warmed plate, broken up, and powdered. These latter iodides (the corresponding bromides may be prepared in the same way) contain an indeterminate percentage of water.

Cadmium iodide can be made from the metal by the same method as ferrous iodide. In crystallizing this beautiful iodide great care is required to avoid discoloring the crystals. Try and find out the trick of keeping the crystals pure, and the cause of the unnatural tinting.

Ammonium iodide crystals also go off color. There is quite a trick in making these crystals that do not turn yellow. A piece of the sesquicarbonate in the bottle, or a drop of ammonium hydroxide will keep most crystals white. Here is a nice problem for the student to solve.

Mercurous iodide is prepared by well triturating mercuric iodide with the equivalent mercury. It is worth trying.

The *soluble bromides* are made through the ferrous salt adding the bro-

mine carefully over periods of time, and with only a single filtration and evaporation to the process. In the case of *ammonium bromide*, bromine is added directly to concentrated ammonium hydroxide, drop by drop from a separatory funnel in a stopper in the neck of the flask containing the ammonia. Keep the bottle cool; as the ammonium bromide crystallizes out it will encase the drops of bromine, and unless the bottle is shaken continually until the free bromine is combined, the heat generated may burst the crystalline "cyst" and, liberating the bromine, cause a bump to break the bottle, unless held in the hand or supported on some soft pad.

As *hydrobromic acid* is easy to make without the preparation of hydrogen sulfide or sulfur dioxide, many bromides are made directly from the acid. For example, weigh out equivalents of bromine and sulfur. Place the bromine in a stoppered bottle with 10% more water than the quantity to make the concentrated 48% HBr solution. Add 5% of the sulfur and shake. The reaction is slow at first, owing to the slight solubility of the bromine in the water, but as the HBr increases in strength the liquid becomes darker and all the bromine will dissolve. At this point put aside a few cc. When all the sulfur is added the reaction is controlled by the shaking. The quiet surface of the Br_2S_2 with the excess sulfur in solution becomes a coating of sulfur and stops the reaction; therefore a flask is not suitable, as the sulfur hardens in a short time if not shaken to keep up the action, and may have to be broken up with a glass rod.

The action is complex, Br_2S_2 is formed by the bromine water, and by the bromine liquid dissolving the sulfur in itself and reacting with the water, ends in a bromine-free liquid containing HBr, H_2SO_4, free S, and a trace of H_2SO_3. The acid is poured through glass wool into a distilling flask in a sand bath. No sulfur may enter the flask, otherwise it will distil over in the free state and as SO_2 throughout the distillation, spoiling the result. When poured into the flask the acid may be cloudy from free sulfur. To remove these last traces, add some of the brown liquid reserved for this purpose, just enough to tint the acid with free bromine when it starts to boil. The first runnings should be used to form the basis of the next batch. The 48% acid distils at 126°C., and may be redistilled for greater purity. This method is used commercially.

The same method may be used to prepare HI, but using a greater volume of water to prevent the reverse action. When the free iodine color is completely discharged and the sulfur settled below the clear solution decant the clear, measure and titrate for H_2SO_4. Prepare a solution of barium hydroxide, titrate, and add sufficient of it to precipitate the $BaSO_4$. Distil in the same way as for HBr. A trace of $Ba(OH)_2$ in excess is advisable; also it is well to stop the distillation before completion. In the case of the HBr, the residual H_2SO_4 in the flask protects the glass, but as all the HI may distil, toward the end it requires constant watching as a

drop of acid may drop off the outlet tube and crack the flask. HI in hot sand is not so good.

The writer has found that when a process is minutely written up, with the equations and theoretical considerations, the student is inclined to take the whole thing for granted and feel he has actually done the thing practically.

For this reason, only the method is given here to prepare the various salts of iodine and bromine. It is advisable for the student to work out his own equations, but if a bookworm, he can look them all up in the literature.

The Teaching of Qualitative Analysis. When I studied qualitative analysis we used the translation of a book by one Remigius Fresenius, who became famous for his good work in analysis. He directed that the material to be analyzed be first submitted to a preliminary examination. Shortly afterward, a teacher, I was blessed with a student called Porter W. Shimer, who soon distinguished himself in the same and other ways. When his course in qualitative analysis was at an end, in advance of the other members of his class, I determined to see how well he could work. To test him, I mixed some beer, sawdust, street sweepings, and several other like conglomerates, added a trace of arsenic and some other metals and handed them over. Some two days later he made a report showing that while he had identified all the anions and cations present, he had also detected the beer, the sawdust, and several other ingredients. It was a notable report for so young a man.

I wonder how many students of this generation would do as well, and I wonder how many modern texts or teachers bother with preliminary examinations. Is it true that our modern teaching is degenerating and that our boys are losing everything by losing that intimacy with their teachers which was so common then and so much less common now? We now have a JOURNAL OF CHEMICAL EDUCATION and laboratories and lecture rooms such as were not then dreamed of, but are we any better or as well off as in the days when Mark Hopkins or Thomas M. Drown on one end of a bench and me on the other represented perfection?

Methodism in teaching seems to me like the beating of drums—sound, but little sense. The good teacher has always been a good and kind man or woman who made friends with the youngsters. There was perfect equality and strenuous work—together. What generous soul can resist such a combination? And how impossible to do without it.

Prof. H. E. Armstrong's wonderful paper in the Dec. 13th issue of *Chem. & Ind.* does not place too much emphasis upon the necessity of moral quality and real attainment in the teacher—and nothing else much matters. The old students who come back to a lovable teacher, like the late Edgar F. Smith, know that nothing they can possibly give him is an adequate return for the benefits they have received.

The impression seems to prevail in many quarters that research qualifications are all that matter much. I was surprised, therefore, to hear Prof. Bradley Stoughton, whose wonderful paper appears in the same issue, say that he thought the most important occupation of a teacher was teaching. Boys and girls are easily led, but they must love and respect their teacher before they can be led at all.—*Letter by Edward Hart in Correspondence of Chem. & Ind.*

THE PURIFICATION OF ACETAMIDE

E. C. WAGNER, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PENNSYLVANIA

Complete purification of acetamide by distillation under ordinary pressure is probably impossible, as the temperature required leads to formation of small amounts of acetonitrile and water,[1] often to discoloration from corks, and as the objectionable odor persists.

For purification by crystallization there have been recommended solvents such as ether, chloroform, benzene, and a mixture of benzene and ethyl acetate. The use of ether yields a well-crystallized product, and reduces or removes the odor, but the slight solubility of acetamide in boiling ether makes this method suitable only for small quantities. The other liquids named have in common the disadvantage that their solvent action upon acetamide is excessive, so that upon crystallization the solution "sets." The crystals cannot be properly separated from the mother-liquor by suction, due to its small volume and high concentration and to the hygroscopic nature of the acetamide, nor by washing with the chilled pure solvent, due to the heavy loss this would entail. Somewhat better results have been obtained, following the use of chloroform as solvent, by washing the crystals with ether. The product obtained in any case is likely to be somewhat odorous, wet in appearance, and it generally melts too low.

The method of purification described herewith is based upon the high solubility of acetamide in methyl (or ethyl) alcohol, its sparing solubility in ether, and the fact that a concentrated solution in alcohol, when largely diluted with ether, deposits crystals of acetamide in a state of purity. With small quantities of acetamide most of the required ether can be added without separation of crystals, and upon seeding the highly supersaturated solution crystallization proceeds rapidly. When this operation is conducted carefully large crystals may be obtained, the crystallization affording a striking demonstration of supersaturation. With larger amounts of acetamide crystallization usually begins before all the ether has been added. The filtration and further treatment of the recrystallized acetamide are made easy by the nature of the product and the large volume of the mother-liquor.

Procedure

In a flask dissolve the acetamide in hot methyl alcohol, using 0.5 cc. for each gram of acetamide. If not clear, filter the hot solution rapidly through paper with suction, or through cotton, receiving it in a vessel large enough to permit ten-fold dilution. Wash the flask and filter with warm alcohol, using enough to bring the total alcohol to 0.8 cc. per gram of acetamide. Treat the solution, in the manner described below, with ether in the proportion of 8 cc. to 10 cc. of ether for each gram of acetamide. Introduce the ether at first rather slowly and with stirring, but avoid splashing.

[1] Hitch and Gilbert, *J. Am. Chem. Soc.*, **35**, 1780 (1913).

With *small amounts of acetamide* (*e. g.*, 10 to 20 grams), and in the absence of conditions which will disturb the state of supersaturation, about three-fourths of the ether may be added without separation of crystals or appearance of turbidity. If too much ether is added at this stage the liquid may become turbid and stratify into two layers, a condition which may be remedied, though, with decrease in the amount of acetamide recovered, by dropwise addition of alcohol until the liquid is again homogeneous. Into the clear supersaturated solution drop a minute crystal of acetamide. If large crystals are desired, allow the covered liquid to remain perfectly quiet and at room temperature after seeding. To obtain small crystals and a higher recovery, stir the liquid after seeding, and chill in an ice bath. In either case, after the initial crystallization has occurred, add the remaining ether and allow to stand about an hour.

With *larger amounts of acetamide* crystallization usually begins after about one-fourth or somewhat more of the ether has been added; otherwise it should be started by seeding. As soon as crystals appear stop the stirring, and allow the liquid to rest until the initial crystallization is about complete. Add the remaining ether rapidly, with vigorous stirring, and chill the liquid thoroughly in an ice bath.

Filter off the crystals rapidly with suction, and wash once with chilled ether. Continue the suction only long enough to remove most of the ether, transfer the acetamide to a desiccator, and dry in vacuo or over sulfuric acid. The mother-liquor and wash-ether, if combined and kept for some time in an ice bath, will often yield a second crop of crystals, increasing the recovery several per cent, or more if the main crystallization occurred at room temperature.

The product obtained as just described consists of crisp, well-formed needle-crystals, which are dry and without odor. The recovery varies with the quality of the starting material. With very impure acetamide, slushy in consistency, the yield was about 65 per cent. With crude acetamide melting at about 76° the recovery was 70 to 75 per cent. Recrystallization of pure acetamide permitted recovery of about 85 per cent. Crystallization at room temperature, or with a larger proportion of alcohol, decreases the yield.

Acetamide recrystallized by the above method melted almost invariably at 82° or slightly higher. In no case did repetition of the crystallization of such material, using pure methyl alcohol and anhydrous ether, effect any substantial change in melting point. As a melting point of 83° was recorded several times, it seems quite possible that the true value is higher than 82° as usually stated, and certainly it is higher than 81° as given in "International Critical Tables." The range 82–83° given by Hofmann[2] probably includes the correct value. The boiling point of material which melted at 82–83° was 221.5°. The values stated were obtained with thermometers certified by the Bureau of Standards, and are fully corrected. There were used the procedures recommended by Mulliken.[3]

The purification of acetamide by the method described appeared to

[2] Hofmann, *Ber.*, **14**, 2719 (1891).

[3] "A Method for the Identification of Pure Organic Compounds," Vol. I, 1904 (Wiley and Sons). Melting point, p. 218; boiling point, p. 221.

be about equally successful whether there were used commercial wood alcohol and U. S. P. ether or acetone-free methyl alcohol and anhydrous ether. Ethyl alcohol was used in one trial, and without noticeable change in results. Handsome crystals, whose length was apparently limited by the size of the container, were obtained by use of acetamide, methyl alcohol, and ether in the proportion of 1:1:13, *i. e.*, more alcohol than specified above. Somewhat larger yields were obtained when the proportion of the three substances was 1:0.5:10. The quantities of acetamide taken for the experimental trials ranged from 10 to 500 grams.

The method described has been uniformly successful in the hands of students during several years, and its use has been responsible for a marked improvement in the quality of acetamide prepared. It appears to be much the easiest and most satisfactory procedure available for the purification of acetamide.

FOR THE NEW YEAR. A DECALOGUE OF AIMS

1. To be independent and non-partisan.
2. To stress the importance of background and perspective in the discussion of public problems.
3. To help cultivate habits of thought and action which will make well-earned leisure enjoyable and not a burden.
4. To illustrate the evils that arise through reliance upon the theory of "manifest destiny."
5. To resist the belief that machinery, whether physical machinery or the machinery of organization, is our salvation.
6. To point out the possibilities and the limitations of the scientific method in the regulation of society.
7. To insist that good taste is the essence of good judgment.
8. To contend that economic world leadership is a means, not an end.
9. To suggest standards to which aspiring youth can rally.
10. To be at once critical and constructive.

—An address by Harold de Wolf Fuller, editor of *New York*, delivered at a dinner given him by his friends, quoted from *Education*

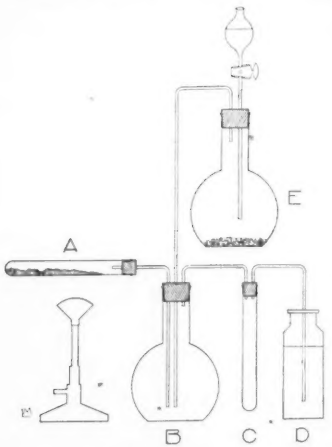
Chromite in Canada. The discovery of chromite on the Wigwam River, in the Obonga Lake district of Northern Ontario, is attracting attention. It was found in a peridotyte dyke, extending several thousand feet. The chromium content varies between 7 and 27%. A series of massive chromite veins has been found at some distance from the contact. Four of these veins have widths of 10 in. to 2 ft., and have been uncovered over a considerable length. These veins average 34% content. Further development will be required to determine whether these deposits are of commercial value. The only chrome iron ore mined in Canada was located in the Eastern Townships, south of the City of Quebec, but these mines have not been operated for some years.—*Chem. & Ind.*

XUM

NITROSYL-SULFURIC ACID: AN EXPERIMENT ILLUSTRATING THE LEAD CHAMBER REACTION

R. D. Billinger and Arthur Rose, Lehigh University, Bethlehem, Penna.

It is rather difficult in an elementary course in general chemistry to require students to prepare sulfuric acid by a process parallel to the Chamber process. This is usually shown to them in the course of lecture experiments. However, it is possible for advanced students to do a certain number of experiments involving considerable manipulation; and occasionally two beginning students working together will enjoy doing something beyond test tube reactions. For this purpose the following experiment has been developed to illustrate reactions in the Chamber process for making sulfuric acid.



A mixture of twelve grams of manganese dioxide and nine grams of flowers of sulfur is heated in an eight-inch hard glass test tube (*A*) and the sulfur dioxide formed is led into a 500-cc. flask (*B*). In the flask (*E*) nitrogen dioxide is generated by dropping concentrated nitric acid on copper clippings. This gas is led into the "chamber" (*B*) and the excess passes on through the safety tube (*C*) and the bottle (*D*). The latter contains concentrated sulfuric acid and is designed to function like the "Gay-Lussac tower" in the commercial plant.

The experiment is begun by carefully heating tube (*A*) until moisture is driven out; then on increasing the temperature sulfur dioxide will issue into (*B*). Next start the reaction in (*E*). Using a low rate of gas evolution, radiation is rapid enough to keep the temperature of the reaction vessel (*B*) below the melting point of the chamber crystals. If the flask (*B*) is dry, beautiful "chamber crystals" will soon coat the walls.

After the sulfur dioxide ceases to form, the bottle (*D*) is removed and the apparatus allowed to cool. Then the flask (*B*) is detached and 10 cc. of water added. Shake the flask to promote reaction between the crystals and water. Then test a small portion of the liquid by adding 5 cc. of a solution of barium chloride. The residue in the test tube (*A*) may be examined by adding a few drops of hydrochloric acid and testing the issuing gas with paper moistened with lead acetate solution.

The sulfur dioxide generator functions smoothly when the reactants are well mixed. If this is not done the sulfur may distil into the outlet tube and plug it.

Several alternative methods can be employed for generating the sulfur dioxide; *e. g.*, copper and hot concentrated sulfuric acid, or still more quickly by dropping an acid on sodium sulfite. However, the oxidation of sulfur is more nearly like the Chamber process. If desired the test tube (*A*) may be replaced by a tube open at both ends. Then the sulfur can be burned in a stream of air which is bubbled through the train.

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS OF THE JOURNAL OF CHEMICAL EDUCATION

FOR PERIOD NOVEMBER 21, 1927, TO DECEMBER 31, 1929*

	Nov. 21/27 to Dec. 31/28	Year 1929	Total
Balance taken over Nov. 21, 1927, from Erle M. Billings, business manager, Educational Division, American Chemical Society	$ 1,013.41	.....	$ 1,013.41
RECEIPTS			
Contributions from The Chemical Foundation, Inc.	$21,000.00	$43,200.00	$ 64,200.00
Subscriptions	19,667.82	17,674.47	37,342.29
Advertising	8,345.98	9,533.50	17,879.48
Reprints	611.31	1,561.28	2,172.59
Service Department—Net	89.51	93.95	183.46
	$49,714.62	$72,063.20	$121,777.82
Total Receipts	$50,728.03	$72,063.20	$122,791.23
DISBURSEMENTS			
Journal Cost:			
Printing Journal	$24,595.85	$52,151.08	$ 76,746.93
Editorial Expense:			
Salaries	$ 6,565.03	$10,629.90	$ 17,194.93
Abstractors' Fees	341.73	459.87	801.60
Traveling Expense	1,490.09	1,115.42	2,605.51
Stationery and Office Supplies	414.51	491.50	906.01
Miscellaneous	500.67	698.11	1,198.78
	$ 9,312.03	$13,394.80	$ 22,706.83
Total Journal Cost	$33,907.88	$65,545.88	$ 99,453.76
Sundry Expense Incurred prior to Dec. 1, 1927	$ 8,823.14	.....	$ 8,823.14
Circulation Expenses — Miscellaneous Printing, Postage, Advertising, etc.	3,655.42	3,457.93	7,113.35
Furniture and Fixtures—Desks, Typewriters, Files, etc.	554.90	223.25	778.15
Printing Reprints	1,234.30	1,983.65	3,217.95
Telephone and Telegraph	102.91	194.60	297.51
Auditing	.....	105.00	105.00
Stationery and Office Supplies	260.71	215.60	476.31
Postage	539.68	554.50	1,094.18
Insurance on life of Dr. Gordon	279.75	283.75	563.50
Miscellaneous	244.35	191.63	435.98
Total Disbursements	$49,603.04	$72,755.79	$122,358.83

* See THIS JOURNAL, **6**, 526 (Mar., 1929).

SUMMARY

Total Receipts	$50,728.03	$72,063.20	$122,791.23
Total Disbursements	49,603.04	72,755.79	122,358.83
Balance in Bank and on Hand, December 31, 1928	$ 1,124.99		
Excess of Disbursements over Receipts for year 1929		$ 692.59	
Balance in Bank and on Hand, December 31, 1929			$ 432.40

We hereby certify that the above statement of Cash Receipts and Disbursements is in accordance with the books of the JOURNAL OF CHEMICAL EDUCATION for the period November 21, 1927, to December 31, 1929.

(Signed) PASLEY AND CONROY,
Certified Public Accountants

Dated February 19, 1930.

Approved:

J. N. SWAN, *Chairman*
MARTIN V. MCGILL, *Vice-Chairman*
R. A. BAKER, *Secretary*
R. M. PARR, *Treasurer*
WILHELM SEGERBLOM, *Past Chairman*
WM. MCPHERSON, *Past Chairman*
NEIL E. GORDON, *Editor-in-Chief*

I LOVE TO TEACH

I do not know that I could make entirely clear to an outsider the pleasure I have in teaching. I had rather earn my living by teaching than in any other way. In my mind, teaching is not merely a life work, a profession, an occupation, a struggle; it is a passion. I love to teach.

I love to teach as a painter loves to paint, as a musician loves to play, as a singer loves to sing, as a strong man rejoices to run a race. Teaching is an art—an art so great and so difficult to master that a man or woman can spend a long life at it without realizing much more than his limitations and mistakes, and his distance from the ideal.

But the main aim of my happy days has been to become a good teacher, just as every architect wishes to be a good architect and every professional poet strives toward perfection.—WILLIAM LYON PHELPS

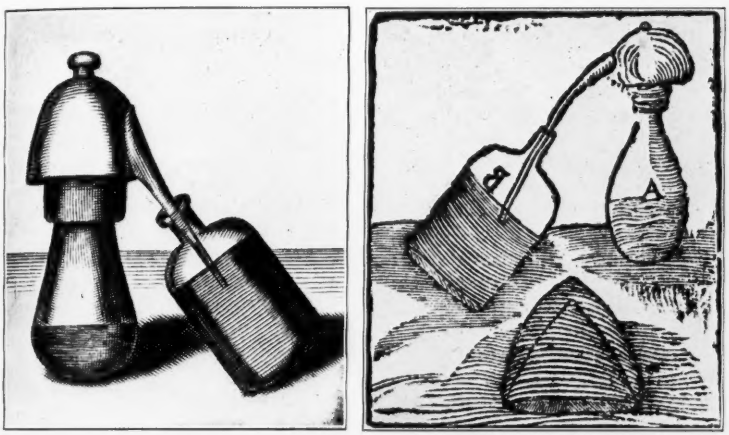
The French "Chemistry House." The French Senate recently voted a credit of 15 million fr. for the acquisition by the State of the Hotel de la Rochefoucauld-d'Estissac as a home for the "Maison de la Chimie" and for the "Foyer Universitaire" (for the University teaching staff). The "Maison de la Chimie" will house the French Chemical Society, the Société de Chimie Industrielle, the Association des Chimistes de Sucrerie et de Distillerie, the Société de Chimie Biologique, the Société de Chimie Physique, the Société des Experts Chimistes, the Association des Chimistes de l'Industrie Textile, the Federation Nationale des Associations de Chimie de France, the Comité National de Chimie, the International Union of Pure and Applied Chemistry, and the Office International de Chimie. There will be a large library and an organization to supply documentation to investigators.—*Chemistry and Industry*

The Chemistry Student

QUESTIONS FOR THE STUDENT OF ELEMENTARY CHEMISTRY

TENNEY L. DAVIS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS

The first picture here reproduced is from the *Currus Triumphalis Antimonii* (Triumphal Chariot of Antimony) of the fictitious Benedictine monk of Erfurt, Basil Valentine, published in Latin with the commentary of Theodore Kerckringius, Amsterdam, 1685. The work was first published in German early in the seventeenth century by Johann Thölde who



WHAT IS WRONG IN THESE PICTURES?

claimed to have discovered it in an ancient manuscript but probably wrote it himself. It is one of the earliest of chemical monographs, and contains clear and adequate directions for the preparation, from the natural sulfide, of antimony metal, of the oxide, chloride, oxychloride, oxysulfide, and of various other compounds of antimony.

The second picture is reproduced from an Italian book, *Faramaceutica Antimoniale overo Trionfo dell' Antimonio*, by Carlo Lancillotti, Modona, 1683. The book summarizes the writings relative to antimony of Basil Valentine, Paracelsus, Penotus, Quercetanus, Milius, Sennert, Beguinus, Angelo Sala, and many others. It shows that the chemists of the seventeenth century had not only a first-class manipulative skill but an amazing amount of accurate qualitative knowledge of the chemistry of antimony.

THEODORI
KERCKRINGII
DOCTORIS MEDICI
COMMENTARIVS
IN
Currum Triumphalem Antimonii
BASILII VALENTINI,
A se Latinitate donatum.
Gh. Andr. Cuchyon. St. 1705.

AMSTELÆDAMI,
Apud HENRICUM WETSTENIUM,
cIↃ IↃc Lxxxv.

THE TWO TITLE PAGES OF KERCKRINGIUS' COMMENTARY

Both books were written, as their titles indicate, because their authors believed strongly in the medicinal value of antimony preparations. The use of these medicines had previously led to such abuses that the French Parliament, acting on the recommendation of the Medical Faculty of Paris, had forbidden their use in 1566. Paumier, a chemist and physician of Caen, had been expelled from practice in 1607 because he persisted in using them. The legislation against them was repealed in 1624. Early in the seventeenth century Sala insisted upon the precautions which are necessary when using compounds of antimony. "Whoever loves his health," said he, "must take care with these medicaments. Unlike arsenic which is naturally poisonous, antimony may acquire poisonous properties by combining with other substances—just as mercury, which is not a poison by itself, becomes a poison in the state of sublimate."

The Dutch publishers of the seventeenth century had the pleasant habit of issuing their books with two title pages. The first or engraved title page generally carried a picture of considerable artistic merit and gave only the bald title of the book, while the second or printed title page really fulfilled the functions which were proper to it. The Commentary of Kerc-

kringius on Basil Valentine is supplied with a very beautiful engraved title page by Romijn de Hooghe, dated 1674, representing the triumphal chariot of antimony. The Italian book contains two folding plates, one of which pictures the triumph of antimony as being similar to that of a Roman Emperor returning from his conquests in a chariot drawn by Nubian lions. The affair appears to be taking place with full benefit of clergy. The Emperor walks, his conquered kings preceding him, while Time and Health ride in the chariot, with Antimony, surrounded by the utensils of chemistry, on top of it in the place of greatest honor.

Many of Basil Valentine's directions for the preparation of antimony compounds are satisfactory laboratory directions for the student of today. He can carry them out, with slight modification, with apparatus which he can find in the high-school laboratory. The processes, three centuries old, are a challenge to him. Can he write formulas for the reactions which are involved in the

FOLDING PLATE FROM LANCILLOTTI'S BOOK
Showing another conception of the triumphal chariot of antimony.

experiments described by our author? Can he tell why certain steps are required in the procedure?

See what you can do with the following directions of Basil Valentine.[1] (Remember that "Antimony" means the mineral stibnite, Sb_2S_3, and that "Regulus of Antimony," little king of antimony, means the metal.)

1. Take best Hungarian Antimony, or any kind you can get, pulverize it as finely as possible, spread thinly on an earthenware dish (round or square) provided with a low margin; place the dish on a calcinatory furnace over a coal fire, which should at first be moderate. As soon as you see smoke rise from the Antimony, stir it about with an iron spoon, and continue doing so till there is no more smoke, and the Antimony sticks together in the shape of small globules. Remove it from the fire, pulverize again into a fine powder, place it on the fire, and calcine as before, till there is no more smoke. This calcination must be repeated not only till the Antimony gives out no more smoke, but does not conglomerate into globules, and has the appearance of pure white ashes. Then has the calcination of Antinomy been successfully completed.

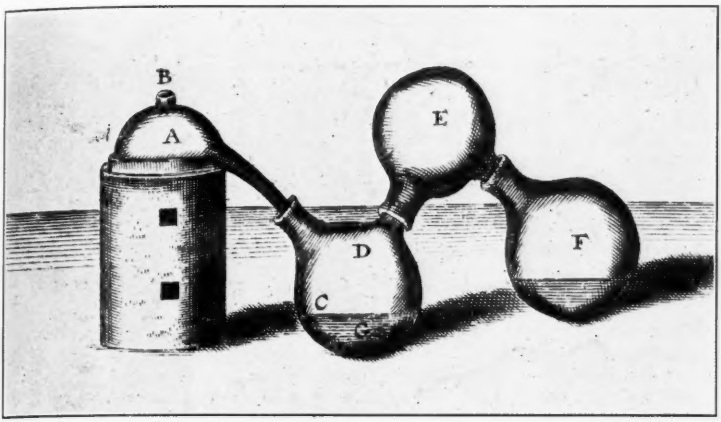
[What are the reddish colored, fusible globules? Why is it necessary to break them up in order to accomplish the successful preparation of antimony oxide? What would happen if the heat were too strong?]

2. Place this calcined Antimony in a crucible, such as goldsmiths use for melting gold and silver, and set it over a violent fire, either lighted in a wind furnace or increased by means of the bellows, till the Antimony becomes liquid like pure water. To test whether the Antimony has acquired its proper glassy transparency, dip in it an oblong piece of cold iron, and examine carefully the Antimony which clings to it. If it be clear, pure, and transparent, it is alright, and has attained its due maturity. The tyro, or beginner, should know (these remarks are addressed to beginners who are students of the Spagyric Art) that glass, whether prepared from metals, minerals, or any other substance, must be subjected to heat, till it has attained to maturity, and exhibits a clear and pellucid transparency. . . . When Antimony has become vitrified in the way described, heat a flat, broad, copper dish over the fire, pour into it the Antimony in as clear and thin a state as possible, and you will have pure, yellow, pellucid glass of Antimony. This preparation of what I call the glass of Antimony is the simplest, best, and most efficacious with which I am acquainted.

3. Common glass of Antimony is pulverized; six grains or more are absolved in warm wine overnight; in the morning the wine is drunk without the sediment, and purges, both by laxation and vomiting, on account of the poisonous crudeness which still remains in the glass of Antimony.

[Knowing that wine contains a certain amount of potassium hydrogen tartrate, what soluble compound of antimony would you expect to be formed? Is the author correct in ascribing the potency of his medicine to the "poisonous crudeness which still remains in the glass of Antimony?" If a sample of the same wine were allowed to stand over night in a cup of metallic antimony, would the resulting medicine be weaker or stronger than that which is described?]

[1] The quoted passages, unless otherwise noted, are from "The Triumphal Chariot of Antimony" (an English translation by Arthur Edward Waite of Kerckringius' book of 1685), London, **1893.**



APPARATUS OF KERCKRINGIUS FOR THE PURIFICATION OF ANTIMONY TRICHLORIDE ACCORDING TO BASIL VALENTINE

4. Take one part each of finely pulverized Antimony and pulverized salt-armoniac [ammonium chloride], so called because it comes from Armenia: mix these together, place in a retort, and distil together. On the product of this distillation pour hot distilled (common) rain water, removing thereby every salt and acrid taste [washing thoroughly]. Then the Antimony will be of a pure, brilliant, and feathery white.

[Write reactions.]

5. There remains another extraction by means of a certain caustic water, which experience teaches ought to be carried out in this fashion. Take vitriol [sulfuric acid] and common salt [and antimony sulfide], equal parts of each. Take the water distilled from these *per latus*. When this is urged strongly by the fire, it yields a substance similar to butter or olive oil.[2]

[These directions are not especially clear. The author evidently means that antimony sulfide, sodium chloride, and sulfuric acid are to be distilled together. The reagents being moist, the acid probably not being anhydrous, the product is a watery liquid—a solution of antimony trichloride in aqueous hydrochloric acid. When this is distilled in the apparatus of Kerckringius, fractional condensation occurs and the trichloride collects in the first receiver, the aqueous portion in the second. Write the reactions.]

6. Pulverize pure Hungarian Antimony, and an equal quantity of thrice-purified saltpeter; burn this composition all together in a new glazed pot, which is free from grease, over a circulatory fire, but not all at once. (This operation the ancients called detonation.) Then pulverize the hard matter which remains in the pot; pour over it moderately hot ordinary water, and when the powder has settled at the bottom, add

[2] New translation from the Latin.

more water, till all the saltpeter is extracted. Dry the substance, and again add to it its own weight of saltpeter; burn again, and repeat this operation three times.

[Write reactions.]

7. Take equal parts of the best Hungarian Antimony and crude tartar [potassium hydrogen tartrate], and half the quantity of saltpeter; pound together, melt over a wind fire, pour into a copper dish, allow to cool, and you will find the Regulus. The Regulus is thrice, or oftener, purified with tartar and saltpeter till it becomes of a brilliant silvery white.

[What reactions would occur if a mixture of antimony sulfide and potassium hydrogen tartrate were heated? How does it happen that the mixture of potassium nitrate and potassium hydrogen tartrate acts upon antimony sulfide in a manner so different from either of these substances alone? Write the reactions.]

8. Pound together one pound of Antimony, half a pound of common salt, and five pounds of broken bricks; place in a retort and distil a yellow oil, when all the spirits will pass away. Pour into a fresh vessel, and remove its oiliness [by washing with water]; there remains a powder, which, spread on a stone in a humid place, and you will have a humid balm which is of great efficacy against foul wounds.

[What is the purpose of the powdered brick? Does it take part in the reaction? Write equations.]

9. Sulfur of Antimony may also be prepared in the following manner: Pulverize the Antimony, and digest for two hours, or longer, in strong lye made of the ashes of beechwood. Strain, add vinegar, and the sulfur will be of a red color, and sink to the bottom; pour off the liquid, and dry the powder gently.

[The reddish brown powder is the material which the alchemists called *kermes*. What is the source of the odor produced during the boiling? How does antimony sulfide react with boiling aqueous potassium carbonate? What is the effect of adding dilute acetic acid? What would be the effect of hydrochloric acid on the product?]

10. Take two parts of Hungarian Antimony, and one part of steel; melt with four parts of burnt tartar [potassium carbonate] in an iron basin, such as those in which goldsmiths refine gold. Cool, take out the Regulus, remove all impurities and scoriae, pulverize finely, add to it, after ascertaining its weight, three times as much burnt tartar; melt, and pour into a basin as before. Repeat a third time, and the Regulus becomes highly refined and brilliant. If you have performed the fusion properly—which is the point of greatest importance—you will have a beautiful star of a brilliant white. The Star is as distinct as if a draftsman had traced it with a pair of compasses.

[The star which so fascinated the alchemists is caused by the crystallization of the antimony button. What is accomplished by submitting the first crude regulus to a second and third treatment with potassium carbonate? From a given weight of antimony sulfide, which method, this or the one described earlier, would give the better yield of metallic antimony? Why? Which would yield the purer product?]

FROM CORN TO KARO

HOWARD R. WILLIAMS, WESTERN RESERVE ACADEMY, HUDSON, OHIO

During the past few years, it has become our custom at Western Reserve Academy to have each student in the chemistry course choose some well-known and much-used product of chemical manufacture, make a study of the processes used in its making, and then produce the product, on a small scale in the laboratory. We do this as a means of showing the student the tremendous importance of chemistry to him personally, and at the same time to open new windows of vision through which he might catch a glimpse of chemistry as the underlying science of industry. This research—so-called by us—has completely supplanted the old semester paper which was supposed to, but never did, quite attain this same goal.

The project method begins where the semester paper should have begun, *i. e.*, with the student's interest. The students choose their own products to be made in so far as possible. A few, of course, will have no ideas, hazy ideas, or quite impractical ideas. These must be guided and helped into workable ideas. To the great relief and joy of the teacher and the deep satisfaction of the students, a very great many of the class will select their own tasks. This starts the job off with an eager interest that no assignment of topics for semester papers could ever hope to approach.

The next step is for the student to gather all the available information possible on the manufacture of the product he has chosen. This includes reading in school and near-by libraries, letters to manufacturing plants which make the product under investigation—and these letters are almost always courteously and helpfully answered—and, whenever possible, visits to a plant where the product being studied is manufactured.

Next, the instructor and student go into conference where the student presents his findings and, with the instructor acting as consulting chemist, plan together the apparatus and work schedule for the "research." The student then attacks his problem in a physical way with the instructor in the background, but always ready to come to the aid of the student when an S. O. S. is sounded for help or advice.

The student makes a full written report of the project when the "research" is completed. This report is graded and corrected, and presented to the class by the student as a finishing touch to his task. If, in the opinion of the instructor, the "research" has been very well and completely done, and the written report is of real value for future reference, it is then typewritten and bound for the school library shelves. We always bind three copies; one for the student, one for the library, and one for the instructor. I might say in passing that the writer is the proud possessor of five or six such "volumes" which to him are priceless.

As an example of the type of project in question, I will describe one of

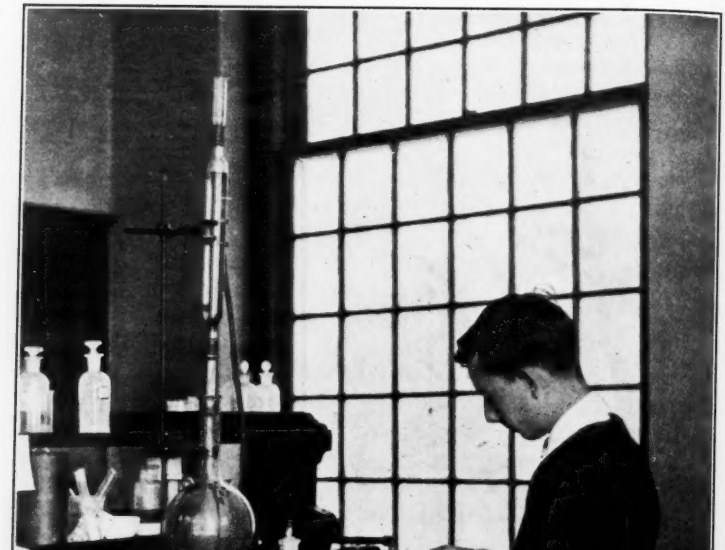


FIGURE 1.—THE BOY WHO MADE THE KARO AT WORK ON HIS PROJECT

our recent ones under the title used by the boy in his written report, "From Corn to Karo."

As stated above, one of the first steps taken by this boy was to write a letter asking for help from the Corn Products Refining Co., Kansas City, Missouri. From this firm he received literature, some charts of corn products, and a very fine set of display samples of their products.

While awaiting a reply from the letter to the manufacturer, the student

delved into the literature at hand, even going into the biology of the physical structure of the corn kernel. At the conference between the student and the instructor, the apparatus shown in Figures 2 and 3 was decided upon, and the student was then ready to set to work.

First, about two liters of sulfurous acid were made by generating sulfur dioxide from concentrated sulfuric acid and zinc and passing the gas through water. The sulfur dioxide may also be made in any one of several other ways, *e. g.*, sulfuric acid on sodium sulfite, heating sodium hydrogen sulfite, or burning sulfur and drawing the sulfur dioxide through the water by means of an aspirator. In the past we have used all of these methods with about equal success.

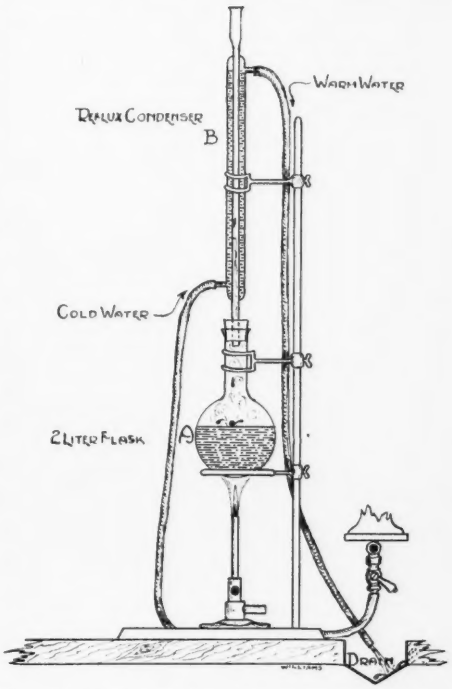


FIGURE 2.—THE APPARATUS FOR THE HYDROLYSIS

About a liter of whole kernels of corn was then soaked in the sulfurous acid for about two hours to soften the kernel, toughen the testa or outer coat of the kernel, and at the same time to bleach the starch. Soaking the kernels in water only would make it possible to obtain just as much starch quite as easily, but the use of the sulfurous acid gives a much whiter starch and a superior finished product. The corn was next ground in water, in small portions, in an iron mortar and thrown into a battery jar half full of water. Here the germ of the corn, which contains the oil, floated to the surface and was skimmed off. The hulls and the starch of the cotyledon, being heavier, settled to the bottom of the jar. The hulls being quite tough after the soaking did not grind up very finely, but the starchy cotyledon was quite completely powdered. By stirring and then straining through a piece of cheese-cloth, the hulls were separated from the starch which passed through the cheese-cloth with the water. The starch was then allowed to settle and the water decanted. The starch was then washed

three times with clear water. After each washing the starch was allowed to settle and the water decanted. After the last washing the starch was filtered out and dried. We obtained a very fine white starch as the result of this part of the process.

The next step was to hydrolyze the starch to glucose or corn sirup. This required the addition of one molecule of water to each molecule of starch

$$C_6H_{10}O_5 + H_2O \longrightarrow C_6H_{12}O_6$$
$$\text{starch} + \text{water} \longrightarrow \text{glucose}$$

The apparatus shown in Figure 2 was set up for this hydrolysis. About half of the starch obtained was placed in the two-liter boiling flask (A) and to it was added about one and one-half liters of a three per cent solution of sulfuric acid. The sulfuric acid is used as a catalyzer to make the above reaction possible. It was found that best results were obtained in this hydrolysis by using distilled water. The mixture of starch and three per cent sulfuric acid was boiled for about three hours. By means of a one-hole cork stopper, a reflux condenser (B, Figure 2) was attached to the neck of the boiling flask so that the volume of the liquid in the flask (A) would not be diminished. Two or three drops of the liquor in flask (A) were taken as a sample, after three hours of boiling, and tested with iodine solution for the presence of unchanged starch. A blue coloration denotes the presence of starch. The boiling was then continued if necessary until this test showed that all the starch had been hydrolyzed. It was found that from three to five hours were required depending upon the amount of starch placed in the boiling flask.

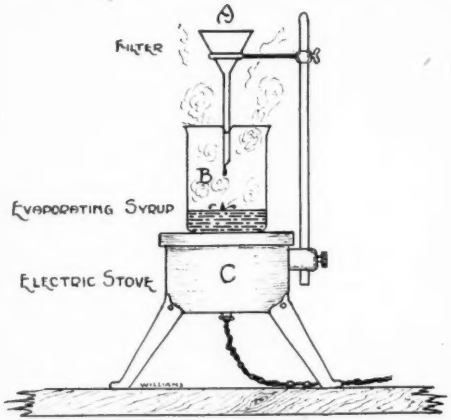


FIGURE 3.—THE APPARATUS FOR SIMULTANEOUS FILTRATION AND CONCENTRATION OF THE THIN LIQUOR

After the hydrolysis was complete, the next step was to neutralize and remove the sulfuric acid catalyzer. This was done by adding the calculated amount of barium hydroxide dissolved in as small a volume of boiling water as possible. In actual practice, it was found that a little additional barium hydroxide solution was necessary, probably due to the occlusion of a small amount of the hydroxide in the forming precipitate of barium sulfate. The neutral point was determined by the use of litmus paper.

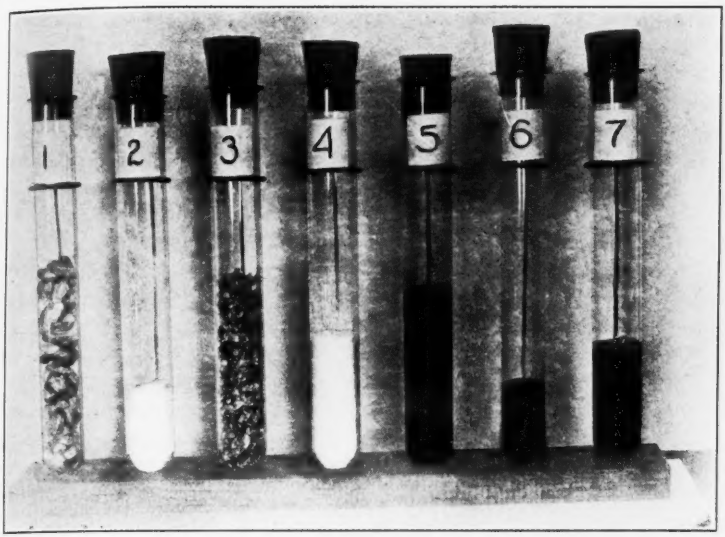


FIGURE 4.—PRODUCTS AND BY-PRODUCTS OF KARO MANUFACTURE

(1) Corn, the starting point, (2) corn starch, (3) the hulls after removal of the starch, (4) barium sulfate obtained in the removal of the sulfuric acid, (5) crude sirup that was not purified, (6) animal charcoal used in purifying the sirup, (7) the purified and finished Karo.

This scheme of neutralization departs from the method used in the manufacture of corn sirup in the factories, but seemed best for use in small quantities as it leaves nothing in the solution but glucose and water.

The neutralized solution of glucose was of a reddish yellow color after the acid was removed and the barium sulfate filtered out. The next step was to remove some of the color and also some disagreeable odors due to the presence of impurities. Upon concentration the color deepened to a very dark brown, and the disagreeable odor of the impurities became more and more pronounced. This purification was accomplished by boiling the solution for a few minutes with animal charcoal and then filtering. It was found that by purifying twice, a product that compared very favorably, indeed, with the best grades of corn sirup was obtained.

Because of the length of time required to filter out the used charcoal and also to concentrate the sirup by evaporation, a scheme was devised for saving time by performing both operations simultaneously, as shown in Figure 3. A beaker (*B*) was placed upon a small electric stove (*C*), and the filter (*A*) was placed over the beaker so that the filtrate dropped into it. The electric stove proved much superior to a Bunsen flame for evaporating the sirup because the splatters of sirup upon the sides of

the beaker—due to the boiling—were not charred as happened very easily when a Bunsen flame was used. If the splatters are allowed to char, the finished product will be dark in color and disagreeable and strong in taste and odor.

The product obtained by the above method was a thick sirup of light amber color, very pleasing to the taste and smell. Indeed, the flavor of the product was so agreeable that we had difficulty in keeping enough of the sirup from the other interested members of the class to be used in an exhibit of the products and by-products of the project.

From an educational standpoint it would seem that the above project, as well as many others like it, is of very great value. It is surprising to note the number and type of educational objectives in chemistry that are included in this project. Below is a list of twenty-two objectives which are brought to the attention and serious study of the student in a most natural and practical way. This list makes no pretense of being complete, and could undoubtedly be enlarged by more careful analysis of the project. It does show, however, the broad scope of this type of chemical education. These objectives are stated in the more common infinitive form.

1. To use the principle of oxidation to obtain an oxide. (Sulfur to sulfur dioxide.)
2. To make an acid from an acid anhydride and water. (Sulfurous acid from sulfur dioxide and water.)
3. To use sulfurous acid as a bleaching agent. (Starch bleached by soaking corn in sulfurous acid.)
4. To wash a precipitate. (Washing the starch.)
5. To use decantation as a method of separation. (Decanting water from the starch.)
6. To use filtration as a method of separation. (Filtering water from starch, liquor from barium sulfate, liquor from charcoal.)
7. To assemble chemical apparatus.
8. To make a solution of a given percentage composition. (3% sulfuric acid solution.)
9. To weigh accurately. (Weighing sulfuric acid for boiling solution and barium hydroxide for neutralization.)
10. To use a catalyzer. (Sulfuric acid.)
11. To use condensation as a means of recovering vapors. (Reflux condenser.)
12. To test samples for the presence of certain substances. (Iodine test for starch.)
13. To make use of hydrolysis. (Hydrolyzing starch to glucose.)
14. To use neutralization to remove an acid. (Removal of the sulfuric acid catalyzer.)

15. To write chemical equations. (For the hydrolysis of starch to glucose, and the neutralization of the sulfuric acid.)
16. To calculate the required weight of one substance to react with a known weight of another. (Calculated weight of barium hydroxide added to known weight of sulfuric acid.)
17. To choose the proper hydroxide for a special case of neutralization. (Barium hydroxide chosen because it leaves only an insoluble sulfate and water.)
18. To make use of solubility rules and tables. (Solubility of barium hydroxide in hot water, and insolubility of barium sulfate.)
19. To use precipitation as a means of separation. (Sulfuric acid removed as precipitated barium sulfate.)
20. To increase the concentration of a solution. (Evaporation of thin liquor to thick sirup.)
21. To use evaporation as a means of concentration. (Getting the sirup from the liquor.)
22. To use charcoal to adsorb undesirable colors, odors, and tastes. (Purification of sirup by use of animal charcoal.)

Beside the chemical and scientific educational value of such a project, it has very distinct values in other fields of education as well. The head of our English department tells me that the ante-project reading and note-taking and the post-project writing and speaking before the class embody almost if not quite as many English objectives as the actual work employs in the field of chemistry. It would seem then that the great educational possibilities of such a project removes it far from the classification of a "chemical stunt," and place it on a firm foundation of practical education.

Melting Point of Palladium. The highest standard point in the thermometric scale which can be measured conveniently with the gas thermometer is the melting point of gold, 1063 °C. Above this, recourse is usually made to radiation thermometry, with, for technical purposes, an agreed value for the radiation constant (c_2). It is, however, useful to have other higher fixed points, and of these the most important is the melting point of palladium. One determination of this was reported in the *Bureau of Standards Journal of Research* for May of this year, yielding the value 1554°. A second determination, made at the National Physical Laboratory by F. H. Schofield, is described in the *Proceedings of the Royal Society* for October, and gives the temperature as 1555°. Older determinations, made at the Physikalisch-Technische Reichsanstalt in 1919 (1556°), and at the Nela Laboratories in 1920 (1557°), are also in remarkably good agreement with the new numbers, and it thus seems probable that the agreed value of 1555° which has been taken as the melting point for the purposes of the International Temperature Scale cannot be in error by more than 2°. It is an interesting fact that Prof. Callendar obtained a value only five degrees below this in 1899, working with a resistance thermometer of platinum, and extrapolating from the boiling-point of sulfur.—*Nature*

CHEMISTRY FOR THE AMATEUR PHOTOGRAPHER. V. REDUCTION, INTENSIFICATION, AND TONING*

Reduction

By reduction in photography is meant the removal of some silver from the image so as to produce a less intense image. Thus, in the case of an over-developed film or plate there will be too much density and contrast, and the negative may be reduced to lessen this. In the case of an over-exposed negative there may not be an excess of contrast but the negative will be too dense all over, and in this case what is required is the removal of the excess density.

It is unfortunate that the word "reduction" is used in English for this process. In other languages the word "weakening" is used, and this is undoubtedly a better word, because the chemical action involved in the removal of silver from a negative is oxidation, and the use of the word reduction leads to confusion with true chemical reduction, such as occurs in development.

All the photographic reducers are oxidizing agents, and almost any strong oxidizing agent will act as a photographic reducer and will remove silver, but various oxidizing agents behave differently in respect to the high lights and shadows of the image. Reducing solutions can be classified in three classes:

A. Cutting reducers
B. True scale reducers
C. Flattening reducers.

A. The cutting reducers remove an equal quantity of silver from all parts of the image, and consequently remove a larger proportion of the image from the shadows than from the high lights of the negative. The typical cutting reducer is that known as *Farmer's Reducer*, consisting of a mixture of potassium ferricyanide and hypo, the potassium ferricyanide oxidizing the silver to silver ferrocyanide and the hypo dissolving the latter compound. Farmer's Reducer will not keep when mixed, decomposing rapidly, so that it is usually prepared by making a strong solution of the ferricyanide and then adding a few drops of this to a hypo solution when the reducer is required. It is especially useful for cleaning negatives or lantern slides which show slight fog, and is also used for local reduction, the solution being applied with a brush or a wad of absorbent cotton.

FARMER'S REDUCER

Solution A

	Avoirdupois	Metric
Potassium Ferricyanide	15 grains	1.0 gram
Water	1 ounce	32.0 cc.

* This series of articles is based upon selected chapters from "Elementary Photographic Chemistry" and "The Fundamentals of Photography," by Dr. C. E. K. Mees, published by the Eastman Kodak Company, Rochester, New York.

Solution B

Hypo	1 ounce	30.0 grams
Water	32 ounces	1.0 liter

Another cutting reducer is permanganate. The permanganates are very strong oxidizing agents, and if a solution of permanganate containing sulfuric acid is applied to a negative, it will oxidize the silver to silver sulfate, which is sufficiently soluble in water to be dissolved.

PERMANGANATE REDUCER

Stock Solution A

	Avoirdupois	Metric
Water	32 ounces	1.0 liter
Potassium Permanganate	$1^3/_4$ ounces	52.5 grams

Stock Solution B

Cold water	32 ounces	1.0 liter
Sulfuric Acid C. P.	1 ounce	32.0 cc.

Permanganate has only a very weak action on a negative if no acid is present and this may be made use of for the removal of "dichroic" fog, the yellow or pink stain sometimes produced in development. Dichroic fog consists of very finely divided silver and this is attacked by a solution of plain permanganate (about 0.25%) which will have no appreciable action on the silver of the image.

An important difference should be noted between the behavior of ferricyanide and permanganate when used for reducing pyro-developed negatives. In a negative developed with pyro the image consists partly of the oxidation product of the pyro associated with the silver. When such a negative is reduced with ferricyanide the silver is removed but the stain is unattacked so that the negative appears to become yellower during reduction, though the ferricyanide does not really produce the color, only making it evident by removal of the silver. Permanganate, on the other hand, attacks the stain image in preference to the silver and consequently makes the negative less yellow. Permanganate can also be used as an alternative to ferricyanide for bleaching negatives, since if bromide be added to the solution, silver bromide will be formed and the same bleaching action obtained as with ferricyanide.

In addition to its use for reduction and bleaching, permanganate is employed as a test for hypo, since it is at once reduced by hypo, and the colored solution of the permanganate, therefore, loses its color in the presence of any hypo. It may consequently be used to test the thoroughness of the elimination of hypo from negatives or prints in washing. When permanganate is reduced in the absence of an excess of free acid, a brownish precipitate of manganese dioxide is obtained and sometimes negatives or prints which have been treated with permanganate are stained brown by

this material. Fortunately, manganese dioxide is removed by bisulfite, which reduces it still further, forming a soluble manganese salt. The brown stain can, therefore, be removed by immersion of the stained material in a solution of bisulfite.

A very powerful cutting reducer is made from a solution of iodine in potassium iodide, to which potassium cyanide has been added to dissolve the silver iodide formed during reduction. Iodine is not soluble in water but is soluble in a solution of potassium iodide. To make up the reducer a few iodine crystals are dissolved in a 10% solution of potassium iodide, and five parts of this are added to one part of a 10% solution of potassium cyanide, making up to 100 parts with water for use.

B. Proportional reducers are those which act on all parts of the negative in proportion to the quantity of silver present there; hence they exactly undo the action of development, since during development the density of all parts of the negative increases proportionally. A correctly exposed but over-developed negative should be reduced with a proportional reducer. Unfortunately, there are no single substances which form exactly proportional reducers, but by mixing permanganate, which is a slightly cutting reducer, with persulfate, which is a flattening reducer, a proportional reducer may be obtained.

PROPORTIONAL REDUCER

Stock Solution A

	Avoirdupois	Metric
Water	32 ounces	1.0 liter
Potassium Permanganate	4 grains	0.3 gram
Sulfuric Acid (10% solution)	½ ounce	16.0 cc.

Stock Solution B

Water	96 ounces	3.0 liters
Ammonium Persulfate	3 ounces	90.0 grams

C. Flattening reducers are those which act very much more on the heavy deposits than on the light deposits of the negative, and which will consequently reduce the high lights without affecting the detail in the shadows. Only one such reducer is known, and this is ammonium persulfate. Ammonium persulfate is a powerful oxidizing agent and attacks the silver of the negative, transforming it into silver sulfate, which dissolves in the solution. It must be used in an acid solution and is somewhat uncertain in its behavior, occasionally refusing to act, and always acting more rapidly as the reduction progresses.

Ammonium persulfate is a white crystalline salt, stable when dry. It has been found in the Research Laboratories of the Eastman Kodak Company that the action of persulfate depends largely upon its containing a very small quantity of iron salt as an impurity, and that its capricious

behavior is due to variations in the quantity of iron present. The persulfate supplied as an Eastman Tested Chemical may be relied upon to give a uniform action in reduction.

PERSULFATE REDUCER

Stock Solution

	Avoirdupois	Metric
Water	32 ounces	1.0 liter
Ammonium Persulfate	2 ounces	60.0 grams
Sulfuric Acid C. P.	3/4 dram	3.0 cc.

Intensification

Intensification is photographically the opposite of reduction, the object being to increase contrast. This is done by the deposition of some material on the silver image. A silver image, for instance, can be very much intensified by toning it with uranium, the reddish brown uranium ferrocyanide having very great printing strength and converting a weak negative into one having a great effective contrast for printing purposes. Usually, however, intensification is performed by depositing a silver, mercury, or a chromium compound upon the image, and many photographic intensifiers depend upon the use of mercury. But experience has shown that mercury-intensified images are not as stable as images produced by chromium intensification.

Mercury is a metal which forms two series of salts, the mercuric salts, which are in a higher degree of oxidation, and the mercurous salts.

Many of the mercuric salts are insoluble in water, but mercuric chloride is sufficiently soluble for practical use, and when a silver image is placed in a solution of mercuric chloride, this reacts with the silver and forms a mixture of mercurous chloride and silver chloride.

The bleached image, which appears white, can then be treated in various ways. If it is developed, for instance, both the silver chloride and the mercurous chloride will be reduced to the metal, and in addition to the silver, with which we started, we shall have added to every part of silver an equal part of mercury. Instead of using a developer we may blacken the image with ammonia, which forms a black mercury ammonium chloride and produces a high degree of intensification.

A very powerful method of intensification, used chiefly for negatives made by photo-engravers, is obtained by leaching with mercuric chloride and blackening with silver dissolved in potassium cyanide. The use of the cyanide cuts the shadows very slightly at the same time that the high lights are intensified, so that a great increase in the contrast of the negative is obtained. This is usually known as the "*Monckhoven*" *Intensifier*.

In the case of the chromium intensifier the silver image is bleached with

a solution of bichromate containing a very little hydrochloric acid, bichromate being an oxidizer of the same type as permanganate or ferricyanide. The image is then redeveloped and will be found to be intensified to an appreciable extent. This intensifier has found increasing favor owing to the ease and certainty of its operation and the permanency of the intensified image.

A CO-ED STUDIES CHEMISTRY

Well, my dear, I went to my first chemistry class today and I simply adore it. The instructor asked Mabel what "Chemistry" meant and she told him that she thought it meant the art of designing chemises, then he asked me the formula for alcohol and I simply had to admit that I didn't know but I told him I had a perfectly delicious gin formula if he wanted that. He said no, that gin was not included in the course, and then asked me to name some of the elements, so I named thunder, lightning, storms, and the like and he wanted to know what kind of elements those were. I told him those were the elements when they were let loose. He showed us some of the cutest tricks with little gadgets which he had on the table. He said now here is some hydro-something acid which I am going to mix with lime-water, and it foamed up all over the place. He asked Ethel what it was, then Sue whispered over and said "Seidlitz," but Ethel said it might be a Martini for all she knew. Then he filled a little doojigger with water and said now when I throw this mineral in it you will see a perfect example of chemical combination. When he did, my dear, the whole thing exploded with the most adorable noise, and simply filled the whole room with smoke. He said that would be about enough for today and that he would take us in the lavatory tomorrow where they keep the elements. Isn't it perfectly thrilling?

HENRY DUNBAR in *College Life*

Eijkman, Hopkins Share Nobel Prize in Medicine. Two men who gave to the world the earliest knowledge of the all-important vitamins, Prof. Christian Eijkman, of the University of Utrecht in Holland, and Sir Frederick Gowland Hopkins, professor of biochemistry at the University of Cambridge, England, have been awarded the 1929 Nobel Prize in medicine.

Prof. Eijkman was the first man to produce experimentally a disease of dietary origin. In 1889, when director of the hygienic laboratory at Batavia, Dutch East Indies, he succeeded in producing polyneuritis in fowl by feeding them a diet consisting exclusively of completely polished rice. He had previously noted that this disease resembled closely the disease beriberi occurring in human beings. In both the human and fowl disease, the nerves show the same degeneration, and the symptoms are very similar. In 1921 Professor Eijkman was made a foreign associate member of the National Academy of Sciences in Washington.

Professor Hopkins, in 1906, first demonstrated that an accessory food substance besides proteins, fats, and carbohydrates was necessary for growth, reproduction, and maintenance of life in animals. Since then he has done considerable research on the nature of these accessory substances, which we know by the name of vitamins. Professor Hopkins has been called discoverer of the vitamins.

These two scientists were awarded the Nobel Prize for their researches on the vitamins.—*Science Service*

COMBUSTION

EUGENE W. BLANK,* STATE COLLEGE, PENNSYLVANIA

The Arabian chemist Geber as early as the eighth century stated that the calcination of mercury must be carried out in open vessels to secure the expected results.

Early in the sixteenth century Leonardo da Vinci wrote, "there is smoke in the center of the flame of a burning candle because the air which enters into the composition of the flame cannot penetrate to the center. It stops at the surface of the flame and condenses there." Later Robert Boyle noticed that a burning candle was quickly extinguished in an exhausted vessel. Subsequent experiments showed that air is necessary for combustion.

John Mayow, in a historic experiment, burned a candle in a glass receiver over water. The flame of the candle soon expired and the water level quickly rose in the jar. From this experiment Mayow rightly concluded that air is a mixture of at least two gases. Subsequently he repeated the experiment using a mouse instead of a candle. He found, as before, that the water level in the jar slowly rose and that it was impossible to ignite a combustible body in the residual gas. Mayow did not quite grasp the full significance of the phenomena with which he was dealing, but he came very near the present theory of combustion.

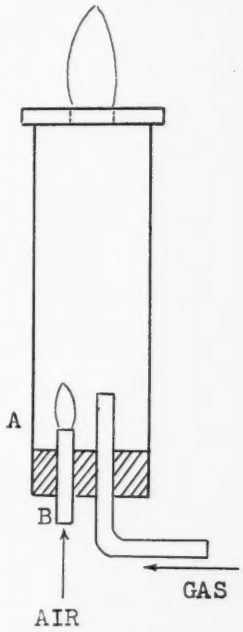


FIGURE 1.—ARRANGEMENT OF APPARATUS TO SHOW RECIPROCAL COMBUSTION

The Arabian chemist Geber knew that the product formed when lead is roasted in the air weighs more than the original metal. The increase in weight was puzzling to him. It was not until 1630 that Jean Rey made some interesting experiments on this subject that were extended by Antoine Laurent Lavoisier with both decisive and far-reaching results. By heating mercury for several days in a sealed retort he was able to show that air is composed of the two gases, oxygen and nitrogen, of which the oxygen alone combines with the mercury. Following this line of work Lavoisier, in 1777, brought forth the oxidation theory of combustion stating that oxygen is necessary for combustion and that the increase in weight of the substance burnt is equal to the decrease in weight of the atmospheric air.

By combustion is usually meant some chemical combination accompanied by the evolution of both heat and light. Were we to adhere strictly to the

* Winner of $10 award in undergraduate contest closing February 15, 1930.

theory of combustion of Lavoisier many chemical reactions would be excluded as not being cases of true oxidation. Hence it is customary to apply the term to any chemical reaction accompanied by the emission of thermal and actinic energy even though oxygen may not figure in the chemical change. Thus if a candle be lowered into a bottle of chlorine gas, combustion continues, although the phenomenon undergoes a change. Volumes of black soot are evolved and the flame becomes orange in color, while at the same time the greenish tinge of the chlorine gas is replaced by a white mist of hydrogen chloride gas. This is a case of combustion, in our sense of the word, even though no oxygen figures in the reaction. In most chemical reactions, however, oxidation plays an important rôle due to the fact that oxygen is the most chemically active constituent of the atmosphere in which we live.

FIGURE 2.—OXYGEN GAS BURNING IN AN ATMOSPHERE OF COAL GAS

Combustion may take place with all conceivable velocities, occurring instantaneously or requiring many years. Practically every one is familiar with the extreme force and rapidity with which electrolytic gas explodes in contact with an open flame. Yet it has been observed that the same mixture of gases combines extremely slowly at room temperature. As the temperature is slowly raised the rate of combustion slowly increases and becomes a measurable phenomenon at about 450°C. The slow decay of wood and the sudden detonation of an explosive are extreme opposite degrees of rapidity of combustion.

It is usual to speak of the burning substance as the combustible, and the atmosphere surrounding it as the supporter of combustion. This choice of terms is merely arbitrary for, from the chemist's point of view, it does not matter whether coal gas burns in air or air in coal gas. There are several ways of showing this reversed or reciprocal combustion. For lecture purposes an apparatus of the type shown in Figure 1 may be

used. The coal gas is ignited at the top of the apparatus and air is drawn in at (*B*). By carefully inserting a lighted splint through (*3*) a flame appears at the top of (*A*) whence we have the phenomenon of air burning in coal gas.

This phenomenon may be shown in a more spectacular manner by inserting a deflagrating spoon of burning potassium chlorate into an atmosphere of coal gas. (See Figure 2.)

Combustion is greatly facilitated by the fineness of division of the reacting members. Pyrophoric powders consist of reduced metals in such an extremely finely divided condition that they inflame when tossed into the air. Lead, iron, and nickel furnish such pyrophoric metals.

Finely divided organic matter suspended in the air forms a highly explosive mixture. Serious explosions, the so-called "dust explosions," have occurred in numerous factories due to this cause.

Most substances require an initial temperature rise before combustion can start and successfully continue. Many reactions are known in which the substances inflame spontaneously with the evolution of light. Various organic compounds, as zinc ethyl and silicoethane, ignite spontaneously in contact with the air. Such reactions are examples of spontaneous combustion.

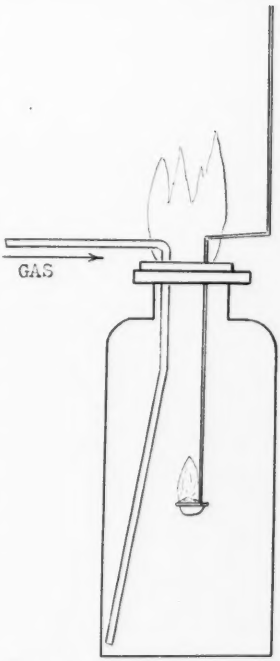


FIGURE 3.—ARRANGEMENT OF APPARATUS FOR BURNING OXYGEN IN COAL GAS

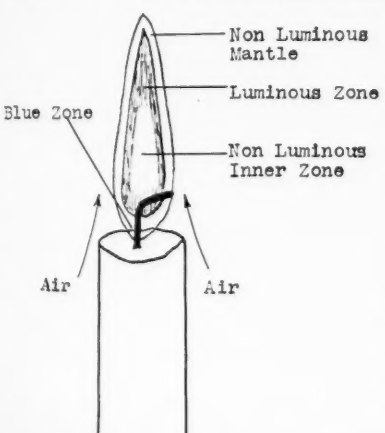


FIGURE 4.—THE PARTS OF THE CANDLE FLAME

The temperature at which rapid combustion becomes independent of external supplies of heat is known as the ignition temperature. In other words, the ignition, or kindling temperature as it is variously called, is the temperature to which the substance must be heated in order to start combustion or ex-

plosion. Substances that are already in combustion can be extinguished by cooling below the ignition point. Thus a candle flame may be extinguished by placing a helix of copper wire about the flame. Sparks below 0.22 mm. in length will not ignite a mixture of hydrogen and oxygen gases. The ignition point of oils is an important physical property and is known as the flash point.

It is hard to distinguish successfully between a rapid combustion and an explosive combustion. As regards gaseous mixtures an explosion may be defined as a reaction which proceeds with a rise of temperature and an ever-increasing velocity until the explosion travels with a uniform maximum rate. This maximum speed has a definite value for each explosive mixture under certain defined conditions. This constant is known as the velocity of the detonation wave and is usually several times as high as the speed of sound in the same mixture of gases.

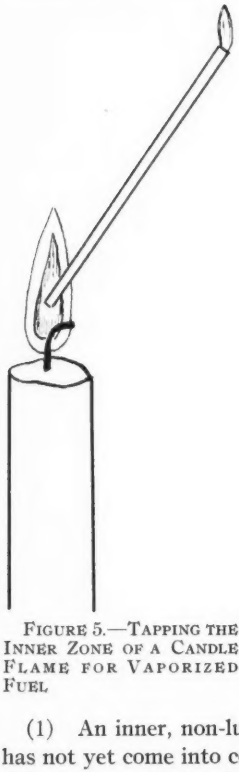


FIGURE 5.—TAPPING THE INNER ZONE OF A CANDLE FLAME FOR VAPORIZED FUEL

The candle ranks high as an object illustrative of the principal points of combustion. The great Faraday made it the subject of a series of lectures. In the candle the fuel is usually solid paraffin wax that is gradually liquefied by the heat of combustion and rising by capillary attraction reaches a hotter zone where it is vaporized and ignited. If a candle be suddenly blown out and the rising vapors brought into contact with a flame they will ignite and, flashing downward, will relight the candle. As the flame continues to burn, cold air is drawn inward and upward, cooling the outer edge of the candle and thus providing a shallow depression to hold the liquefied fuel.

Four zones may be distinguished in a candle flame, namely:

(1) An inner, non-luminous zone which consists of vaporized fuel that has not yet come into contact with the surrounding atmosphere. A short glass tube placed in this zone will allow some of this vapor to be drawn off and it may be ignited at the upper end of the glass tube. (Figure 5.)

(2) A luminous mantle where chemical reactions have begun to take place.

(3) A non-luminous outer mantle where the carbon and hydrogen are completely oxidized by an excess of air to carbon dioxide and water. This is the hottest portion of the flame.

(4) Lastly a small blue zone below the wick.

Wicks for candles are plaited of several cords, one of which is under greater tension than the others. Thus, as the candle burns, the wick curls until the top is in the non-luminous outer mantle where it gradually burns away. If the wick did not curl and burn off it would project into the inner cone of the flame, interfering with proper combustion, and the candle would then require snuffing.

A flame is a mass of gas raised to incandescence by heat. Its formation is not essential to combustion however, since we can have combustion take place with very little flame. It is of interest to inquire the causes of the luminosity of a candle flame. Formerly the theory of Davy, that the luminosity of a candle flame is due to the separation and raising to incandescence of free carbon particles, was considered correct. Frankland, in some experiments on the relation between luminosity and pressure, came to the conclusion that the luminosity of ordinary flames is due to the glow of dense hydrocarbons rather than to the presence of solid carbon particles. This is the generally accepted explanation.

When a stream of gas issues from a circular orifice the gas can only burn at its surface of contact with the surrounding air. The interior of the flame which does not come into contact with the air is unburnt gas and is relatively cool. Such is the case in the common Bunsen burner. A brief examination of the flame is all that is needed to show that it consists of two parts, an inner zone of unburnt gas and an outer non-luminous mantle of vigorous combustion.

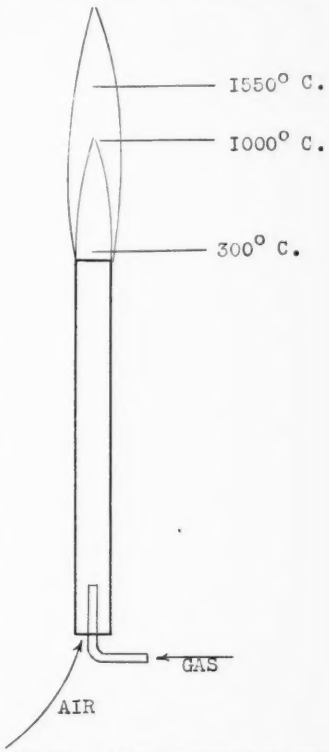


FIGURE 6.—THE PRINCIPLE OF THE BUNSEN BURNER WITH TEMPERATURES OF VARIOUS PORTIONS OF THE FLAME

Various experiments have been devised to show that the inner portion of a Bunsen flame is cool. A square of asbestos paper is painted with red mercuric iodide and quickly pressed down on the flame. A yellow ring indicates the hottest portion of the flame. Gunpowder and matches may be placed in the center of the flame without being ignited.

In 1859 Frankland made some experiments with burning candles to determine the influence of pressure on the rate of combustion and luminosity. He found that differences in pressure do not materially affect the rate of combustion. However, he did discover that the diminution of illuminating power is directly proportional to the diminution of atmospheric pressure. For every fall of 1 inch of the mercury barometer the luminosity falls by 5.1 per cent. The law is applicable to pressures up to three atmospheres but at still higher pressures the luminosity rapidly increases.

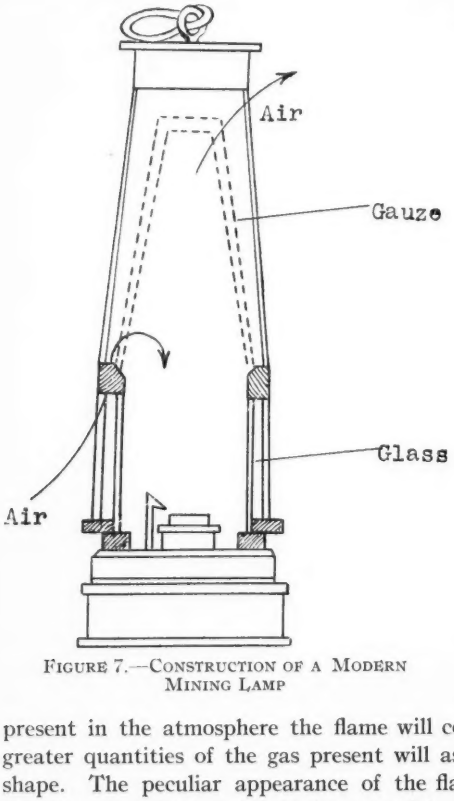


FIGURE 7.—CONSTRUCTION OF A MODERN MINING LAMP

If a square of wire gauze be fixed some distance above a Bunsen burner the gas may be ignited above the gauze without striking back to the orifice of the burner. If the gas be ignited below the gauze it will not catch fire above until the gauze becomes hot.

Such gauze experiments led Humphry Davy, in 1815, to the invention of the mining lamp. Numerous modifications have been made from time to time but the underlying principle remains the same. An oil-fed wick is enclosed by a glass chimney, the upper portion of which is made of wire gauze. Should any marsh gas be present in the atmosphere the flame will commence to flicker and with greater quantities of the gas present will assume a curiously elongated shape. The peculiar appearance of the flame is due to the formation of a flame-cap of burning firedamp which surmounts the flame proper. From the work of E. B. Whalley and W. M. Tweedie it is now possible to form a fair estimate of the amount of marsh gas present in a mine from the elongation of the flame cap of a lamp that has been standardized in an atmosphere containing a known quantity of the gas.

If a piece of platinum wire be heated to redness and then placed in a stream of coal gas and air issuing from a Bunsen burner, the wire will

continue to glow brightly. The coal gas is uniting with the oxygen of the air directly on the surface of the platinum with the liberation of sufficient heat to raise it to incandescence. This is a case of combustion without the formation of a free flame and is known as surface combustion.

This phenomenon gives rise to a very interesting experiment. A short platinum wire is heated and lowered into a beaker containing several cubic centimeters of methyl alcohol. The whole is covered with a sheet of filter paper to prevent the alcohol from catching fire. Under these conditions the platinum glows brightly as the alcohol burns on its surface.

In the Welsbach mantle a like phenomenon takes place. The mantle is so arranged as to become heated to incandescence by the burning gas. The mantles are made by saturating frail cotton fabrics with a mixture of thoria and ceria. For protection in transit the mantles are dipped in collodion and dried.

Acknowledgment

The writer acknowledges his indebtedness to the following references:

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Articles on Combustion and Flame in the Encyclopaedia Britannica, 14th edition, New York, **1929.**

"The Chemical History of a Candle," by Michael Faraday, Volume 30, The Harvard Classics, New York.

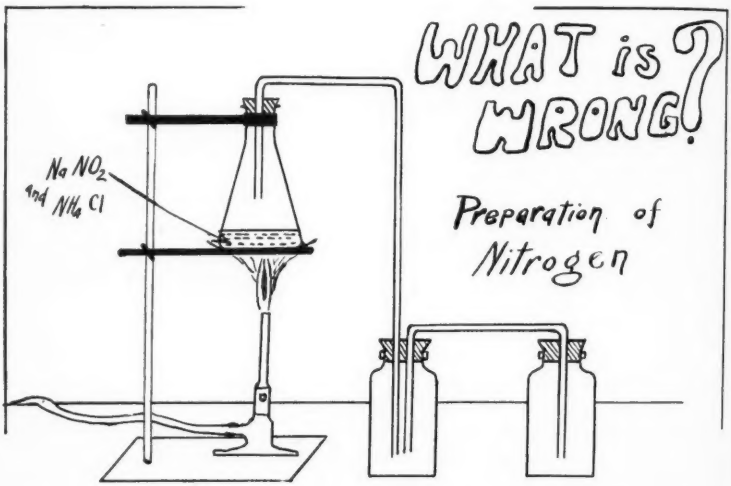
Liquid Crystals and Chemical Constitution. The property possessed by certain chemical compounds of forming liquid crystals has been studied by D. Vorländer, who attempts in two papers in the November issue of the *Berichte der Deutschen Chemischen Gesellschaft* to correlate this property with certain deductions as to the relative orientations of two or more long chains of atoms to one another. It is shown that the non-appearance of liquid crystals in such derivatives of urea and thio-urea as are obtained by introducing two *p*-amino-*p'*-ethoxyazobenzene groupings into the molecule may be due to the angular divergence of these two long groups, which are linked together by the carbonyl or thiocarbonyl group at an angle of 109°. When, however, these compounds are converted to the corresponding diimide by removing water (or hydrogen sulfide), this divergence disappears, since the double linking of each nitrogen atom to the central carbon atom results in a linear configuration —N=C=N— and the pound can exist in the liquid crystalline condition. This evidence is confirmed from a study of the esters which trimesic acid and the three phthalic acids produce with such lengthy chain compounds as *p*-phenetoleazophenol. The star-shaped orientation of the trimesic esters and the angular divergence (60°) of the chains in the ortho-esters seem to preclude the possibility of liquid crystal formation. The meta esters with a divergence of 120° melt to liquid crystals which persist only over a short temperature range, while the para esters, in which the two chains are said to lie in a straight line, are described as supracrystalline, that is to say, the liquid crystalline condition is so stable that the amorphous liquid state is not even attained.—*Nature*

CONTEST FOR HIGH-SCHOOL AND FRESHMAN STUDENTS

On this page is reproduced another of the series of drawings prepared for us by Prof. John J. Condon of William Nottingham High School, Syracuse, New York. Write a brief statement, telling what is wrong with the picture. Use complete sentences; do not merely list mistakes. Type your manuscript, if possible; if not, be sure that you write legibly. Type or write on one side of the paper only.

Make a correct drawing, showing the picture as you think it should be. Use black India ink and white drawing paper. (If you believe that you can draw better on coördinate paper, white paper with blue rulings must be used.) Drawings should be approximately 4″ × 6″ or 8″ × 12″.

Place your name at the top of each page of your manuscript and at the top of your drawing.



On a separate sheet accompanying your manuscript write your own name, the name and address of the institution at which you are a student, the name of your chemistry instructor, and the name of the chemistry club at your institution (if there is one). Include also your home address for many schools will have closed before the winners in this contest are determined.

Address your paper to: The Associate Editor, JOURNAL OF CHEMICAL EDUCATION, The Johns Hopkins University, Homewood, Baltimore, Md.

Your contribution to this month's contest must be postmarked not later than May 15th.

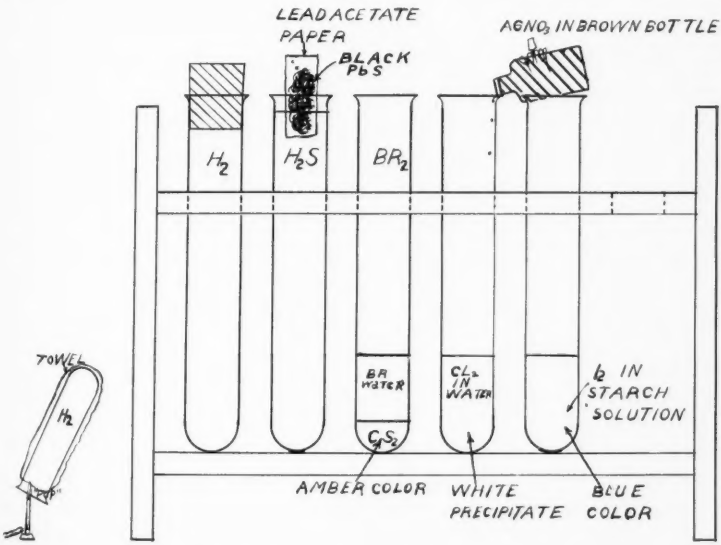
Awards

The best contribution received will be awarded a prize of five dollars. The five next best papers will receive awards of one dollar each.

WINNERS IN SIXTH "WHAT IS WRONG?" CONTEST

The papers submitted in the sixth contest[1] were, on the whole, much better than the drawings which accompanied them. There were a number of good contributions, but the one which received first award ranked several points higher than any of its competitors. We again received a number of weird bits of chemical information. Among them was the statement that Avogadro's hypothesis proves that all permanent elementary gases are diatomic, whereas elementary liquids and solids are monatomic.

The criticism of Mr. Paul Haught, of Morgantown, W. Va., the first-prize winner, follows:



Beginning at the left of the diagram with the tube containing hydrogen, the first thing apparent is the danger with which the experiment is performed. Such a mixture as would result by air mixing with the small quantity of hydrogen would be dangerously explosive. A tube containing hydrogen should be covered tightly or held mouth downward to prevent the escape of the very light gas hydrogen. The test tube should be completely filled with hydrogen. To properly conduct the test, the tube should be wrapped in a towel and introduced into the flame of a burner. Another slight error is the lack of a rack to contain the test tube. This same thing applies to all the other tubes.

In the test for hydrogen sulfide the same thing applies to its volume as to that of the hydrogen, although it is not nearly so important. The practice of holding the nose directly over the mouth of the tube and smelling is dangerous. Some gases are poisonous enough to produce unconsciousness by inhaling even a very slight amount.

[1] See THIS JOURNAL, **7**, 661–2 (March, 1930).

When testing for anything by its odor, the container should be held a foot or more away from the nose and the gas wafted gently toward it by the open hand. Perhaps a more scientific test for hydrogen sulfide is its reaction on lead acetate. A paper moistened with lead acetate solution and brought into contact with hydrogen sulfide will turn black, due to the formation of lead sulfide.

The third part of the diagram represents an error that some students are very prone to make: namely, using too much reagent. Silver nitrate will produce a precipitate with bromine water, but it is yellow, not white. It is rather difficult to distinguish this from a precipitate of silver iodide, so silver nitrate is not regarded as a good reagent in testing for bromine. A solution of bromine water in contact with carbon bisulfide gives an amber color. If bromine is present in the form of a salt, it may be replaced by chlorine and form elementary bromine which dissolves in the carbon bisulfide to give the characteristic color. Bromine water contains combined bromine but since the element is in an equilibrium reaction with water, there is always enough free bromine present to give the test.

An error in laboratory technic is shown by the glass stoppers lying on the desk. They should always be held in the hand. Silver nitrate must be kept in a colored bottle since it decomposes when exposed to light.

Chlorine is a gas with a greenish yellow color and a choky odor. These properties make it possible to detect the gas by purely physical means. If chlorine is dissolved in water and silver nitrate added a white precipitate of silver chloride will be formed which is insoluble in nitric acid but readily soluble in an excess of ammonium hydroxide. Any soluble chloride will give the same test.

Again, in the test for iodine too much reagent is used. Even if a purple precipitate were obtained, it would be almost impossible to see it in the brown colored tincture of iodine. Several things might happen if hot concentrated nitric acid were used. It would probably oxidize both the alcohol, which is the solvent for iodine, and the iodine itself. The latter would probably be oxidized to the pentoxide (I_2O_5). A good test for iodine is to dissolve the suspected substance in a starch solution. Iodine gives a beautiful blue color in this reagent. If iodine is present in the combined form, such as sodium iodide, chlorine or bromine will replace it, setting iodine free, which then dissolves in the starch solution. It also dissolves in carbon bisulfide, giving a deep violet color.

Other contributors suggested the bright-dime test for H_2S, as well as a number of tests for Cl_2, including the bleaching of moistened colored cloth, the support of combustion of a burning H_2 jet, the spontaneous combustion of powdered antimony, and the heated copper-coil test.

Winners of one-dollar awards were: Jane Wood Fernsler, Sunbury, Pa.; Elvira Hernàndez, El Paso, Texas; Dorothy Toft, Bennett, Colo.; John McTigue, Troy, N. Y.; and Mabel H. Miller, Bluffton, Ohio.

Practically all the air must be pumped out of a lamp bulb during the process of manufacture, in order that the lamp have long life. In making one of the tiniest "bug lamps," for instance, about 100,000,000,000,000,000,000 molecules of air are extracted from the little bulb, leaving only about one part in ten million. It is then considered "pumped dry."—*Sch. Sci. Math.*

THE LIBRARY

POPULAR SCIENCE MONTHLY, *April, 1930*

(*P. 19.*) "Fortunes That Farmers Throw Away." *E. E. Free.* Practically every industry in the United States is turning one-time wastes into highly profitable by-products. Agriculture alone is yearly throwing away billions of tons of material that ought to be worth money. In a few cases where there is centralized control and management, such as in cotton growing and fruit canning, by-product industries have sprung up. Now a million-dollar corporation has been formed to convert cornstalks into marketable products. The chief output of the present venture will probably be in the form of synthetic wall board. However, many other products are possible and will probably be developed as time goes on. There are other agricultural wastes in the United States which can and should be converted into useful materials, notably straw. Still others await further chemical investigation to discover profitable uses. (*Illustrated.*)

(*P. 30.*) "Steel Balls Now Used to Carry Helium." Six steel balls mounted on a flat car constitute a novel helium container, recently developed for transporting airship gas from Texas oil fields. Cylinders were formerly used but the new containers permit of higher pressures.

(*P. 30.*) "Harden Steel by New Magnetic Process." Subjection to magnetic fields of repeatedly changed polarity hardens steel just as effectively as heat treatment, according to E. G. Herbert, British metallurgist. Whether this method has commercial possibilities is not yet determined.

(*P. 32.*) "A New Coke Dust Fuel." The Bureau of Mines has found that low-temperature carbonization of coal not only gives a more valuable yield of tars and oils, but leaves as a residue a type of coke which when powdered can be stored for fuel with an unusually high degree of safety.

(*P. 32.*) "Makes 'Artificial Air' for Planes and Subs." Dr. J. W. Hershey of McPherson College, Kansas, has demonstrated that "artificial" atmospheres of helium and oxygen are entirely satisfactory supporters of life. Incidentally, mice kept in atmospheres of oxygen and nitrogen lived only a few days.

(*P. 32.*) "'Electric Eye' Detects Funnel Fumes." *Photograph* with descriptive caption. A photoelectric instrument for regulating ventilation in the Holland tunnel.

(*P. 35.*) "Chemist Fights Deadly Gas." *Photograph* of Dr. J. C. W. Frazer, of the Johns Hopkins University, who has recently developed a catalyst to oxidize the carbon monoxide in auto exhaust gases to carbon dioxide.

(*P. 35.*) "Acetylene as Auto Fuel." *Photographs.* Acetylene gas, mixed with air and water, is fed into automobile cylinders by a special carburetion device.

(*P. 36.*) "Nonpoisonous Dyes Now Paint the Lily." Cut flowers have

long been artificially colored, but most dyes caused the flowers to wilt quickly. Dr. R. B. Harvey, of the Minnesota Agricultural Experiment Station, reports that a number of brilliant, non-poisonous dyes are now available for this purpose.

(*P. 38.*) "Powerful Ray Tube to Bombard the Atoms." A high-powered vacuum tube, operating on 250,000 volts, has been constructed at the California Institute of Technology to furnish electrons of sufficient velocity for experiments in atomic disintegration. (*Photograph.*)

(*P. 38.*) "Shoot Poison Dust to Kill Mosquitoes." During the coming summer the United States Public Health Service will use blowers mounted on trucks and boats to scatter Paris green over mosquito-infested areas.

(*P. 38.*) "Pawpaw Tree Furnishes Food, Soap, Medicine." The tropical pawpaw tree of South America exudes a juice which, when rubbed on meat, makes the toughest beefsteak as tender as venison. Its leaves are used by the natives as a substitute for soap. The sap contains fibrin, which is otherwise found only in the animal world. The seeds are used as a vermifuge. Furthermore, the tree bears a delicious, edible fruit.

(*P. 44.*) "First Photo Took 8 Hours. Now 20,000 in a Second." *H. C. Davis.* An outline of the early history of photography with the emphasis on Daguerre's life and experiments. (*Illustrated.*)

(*P. 46.*) "New Composition Hard as Flint, Flexible as Paper." A new compound of the synthetic resin type is hardened by heating into a hard, tough, flexible material and is to be exploited commercially in the form of unbreakable phonograph records. (*Photograph.*)

(*P. 50.*) "Finds Protons Play Dual Rôle; Wins Prize." The annual award of $1000 offered by the American Association for the Advancement of Science has recently been won by Prof. A. J. Dempster, University of Chicago physicist, who has discovered that protons, as well as electrons, display wave characteristics.

(*P. 52.*) "Blue Aniline Dye Now Used in Fight on Cancer." Berlin cancer specialists have found that small quantities of isamine blue injected into the blood stream are absorbed by cancer cells rather than by normal tissues. This differential coloration aids the surgeon and sometimes discovers small cancer-infected areas which might otherwise be overlooked. In radium treatment the dye is believed to increase the tendency of cancer cells to absorb, and be destroyed by, radium rays.

(*P. 62.*) "$20,000,000,000 in Gold Mined in 400 Years." A "bullion cube" only 38.5 feet high would result if all the gold mined in the world, since the days of Columbus, were cast into one solid block. However, this seemingly small amount would pave four miles of thirty-foot street with a one-inch thickness of the precious metal.

(*P. 132.*) "Home Workshop Chemistry." Formulas for a composition to fill cracks in flooring and for several wood stains.

SCIENTIFIC AMERICAN, *April, 1930*

(*P. 263.*) "Arthur Jeffrey Dempster." Full-page *portrait* of Prof. Dempster, with paragraph telling of his winning of the $1000 prize annually awarded by the American Association for the Advancement of Science. Prof. Dempster has demonstrated that protons have wave properties.

(*P. 264.*) "America's Foremost Physical Laboratory." *Photograph* of the Ryerson Laboratory at the University of Chicago. Michelson, Millikan, Compton, Stratton, Swann, Jewett, Davisson, and Dempster have all worked there.

(*P. 270.*) "Can the World Banish Malaria?" *Theo. Krysto.* The author believes that malaria can best be stamped out in rural districts by the planting of legumes. It is a known fact that the male *anopheles* mosquito feeds by sucking the juices of plants; the female, which carries malaria, feeds partly on plant juices and partly on the blood of animals. According to the author's theory there is something in the juices of leguminous plants which destroys the power of the mosquito to transmit malaria. (*Illustrated.*)

(*P. 302.*) "A Friendly Museum." The Buffalo Museum of Science has been skilfully planned and lighted to eliminate "museum fatigue." Some of the exhibits are described. The article is well *illustrated.*

(*P. 307.*) "Paper-Weight Unbreakable Phonograph Records." Already described in this and last month's Library.

(*P. 309.*) "Watermelon Seed Makes Useful Drug." Cucurbocitrin, an extract from watermelon seeds, has proved useful in relieving cases of high blood pressure.

(*P. 314 et seq.*) "Chemistry in Industry." Includes the following items: "Gas Industry By-Product Aids Agriculture." The effectiveness of sulfur in sprays is determined by the fineness of the particles. Sulfur obtained by removal of H_2S from industrial fuel gas is in colloidal state and hence eminently suitable for agricultural purposes. "Gas and Holder of Blimp Both Chemical Products." The new Navy blimp, the ZMC-2, is covered with Alclad, an aluminum alloy coated with pure aluminum. The ship is floated with helium. "Would Burn Coal Underground." Leo Ranney has devised a process for burning coal underground to produce coal gas, petroleum, or CO_2 accordingly as the supply of air is controlled. "The World's Worst Fire." Oil fires can be controlled by the use of Foamite. (*Illustrated.*) "Asphalt Emulsions Find Uses." Asphalt has hitherto been applied either by melting or by dissolving in volatile solvents. It can now be prepared in stable water emulsions, which are much more satisfactory for many purposes. "Cream-Separator Principle Widely Applied in Chemistry." Some industrial uses of the centrifuge are enumerated. "Concrete without Sand or Stone." Haydite, a light-weight, cellular ma-

terial obtained by roasting shale in rotary kilns, is used as an aggregate in pre-cast concrete slabs for roofing. "Minute Impurity Explains Riddle of Photographic Film." Minute quantities of allyl thiocarbamide make gelatin suitable for the preparation of photographic emulsions. Pure gelatin produces an insensitive emulsion.

(*P. 320.*) "Carbon Monoxide Poisoning." A special committee appointed by the American Medical Association has recently submitted a report on the chief sources of carbon monoxide poisoning. Treatment for poisoning cases is outlined as follows: Artificial respiration, administration of O_2 and CO_2 until pulse and temperature are normal, warmth and avoidance of muscular effort.

(*P. 321.*) "Phosphorous Poisoning from Roach Paste." Some roach pastes contain phosphorus. Due account of this should be taken and baits for rats should not be placed where small children or domestic animals can reach them.

SCIENCE AND INVENTION, *April, 1930*

(*P. 1068.*) "Alloys—a New Basis of Wealth." *Alfred M. Caddell.* The Financial Editor tells of the growing economic importance of metallic alloys.

(*P. 1084.*) "Brains of Silver—Eyes of Glass." A description of the modern camera and film and of some of the processes in their manufacture. (*Illustrated.*)

(*P. 1100.*) "Make a Chemical Nest of Serpents." *E. Bade.* A brief discussion of cyanogen compounds with directions for preparing mercuric thiocyanate. (*Illustrated.*)

POPULAR MECHANICS, *April, 1930*

(*P. 534.*) "Bootleg Liquor Runs Motor with Fuel Vaporizer." An account of experiments with a new vaporizer, designed to utilize alcohol and low-grade gasolines. (The item does not say so, but we judge that the confiscated liquor employed in some of the tests must first have been redistilled.)

(*P. 535.*) "Morning Glory Petals for Acid Test." The petals of the blue morning glory react like litmus paper to acids and bases.

(*P. 539.*) "Chemical to Combat Crime Restores Auto Numbers." Destroyed or obscured numbers on pistols or automobile frames may often be made visible again by etching. (*Photograph.*)

(*P. 540.*) "Hardest Metal (*sic*) Goes Up as New Uses for It Are Found." Tungsten carbide, as a result of increased demand due to new uses, has risen to nearly $500 a pound.

(*P. 544.*) "Big Animals Helium-Filled for Street Parade." Huge helium-inflated balloons made to resemble grotesque animals and comic-strip characters participated in a New York street parade recently.

(*P. 544.*) "Spark-Plug Alloy Maintains Constant Voltage." No details as to the nature of the alloy are given.

(*P. 558.*) "Oil Electroplates Surface Which It Lubricates." A lubricant mixture developed to prevent corrosion in automobile gear boxes and rear axles consists of zinc oxide and mineral oil. Tests showed that not only was corrosion prevented but a 0.02-mm. film of strongly adherent zinc was plated on the working surfaces. No further increase in the thickness of the film takes place.

(*P. 577.*) "Salt Mine beneath Detroit." One of the largest salt mines in the world is 1100 feet beneath an important industrial section of Detroit.

(*P. 592.*) "Rubber Material X-Ray Proof." A rubber composition is being made to replace metals in lining X-ray rooms. A half-inch thickness of the rubber offers protection equal to an eighth inch of lead.

(*P. 593.*) "Queer Quirks of Acid." Some of the properties of sulfuric acid are enumerated.

(*P. 599.*) "Plants Find Plumbing Leak by Reaction to Gas." A number of plants, including the carnation, sweet-pea sprouts, and castor-bean sprouts, are exceedingly sensitive to minute traces of ethylene in the atmosphere and hence can be used as gas detectors.

(*P. 601.*) "Tracks of Invisible Rays Seen in Magic Glass." A commercial demonstration apparatus for demonstrating alpha rays. (*Photograph.*)

(*P. 633.*) "Oil from Sand Opens Up New Source of Supply." Engineers have invented a process for extracting oil from oil-bearing sands.

(*P. 641.*) "A Drug-Store from the Sea." *H. H. Dunn.* Hundreds of useful products are extracted from the sea and from its plant and animal denizens. These include salts, fish oils, fertilizer from kelp, and many others. (*Illustrated.*)

(*P. 645.*) "Human Hair Makes Chemical Important in Diet." Cystine is extracted in crystalline form from barber-shop sweepings.

(*P. 647.*) "Magnetism Hardens Metals." Metals can be super-hardened by magnetic treatment as well as by heat.

Restoring Jute Superphosphate Bags. In evidence given recently before the Australian Commonwealth Tariff Board, it was stated that the wastage due to inability to use jute superphosphate bags more than once amounted in value to some $500,000 a year. Tests have indicated that, on exposure to the sun, bags containing superphosphate rapidly lose color, while the fiber becomes weak and decays; but that a simple and effective remedy consists in shaking the bags free from superphosphate dust, then immersing them in a weak alkaline bath (50 gal. water containing 10 lb. soda crystals or 4 lb. soda ash suffices for 50 bags). Bags treated in this way are fit for use again, and are practically immune from acidic decay.—*Chem. & Ind.*

XUM

REPORT OF COMMITTEE ON PRIZE ESSAYS

On September 16, 1929, letters announcing the 1929–30 Prize Essay Contest of the American Chemical Society were mailed to every high school, normal school, college, and university in the United States. Accompanying the announcement were descriptive booklets, pamphlets, and display posters. Each school receiving such literature had previously been the recipient of reference books donated by the Committee through the courtesy of The Chemical Foundation, Incorporated.

This essay writing project made possible through funds annually contributed by Mr. and Mrs. Francis P. Garvan of New York City, in memory of their daughter Patricia, consists of three distinct and separate contests, namely:

1. A contest to which all students enrolled in high schools are eligible.
2. A contest to which all students enrolled in normal schools and teachers colleges are eligible.
3. A contest to which all freshman students enrolled in colleges and universities are eligible.

High and Secondary School Contest

As stated in the high-school contest booklet, of which 35,000 copies were distributed, the procedure provides for a separate preliminary contest in each state, and a final national contest in which the six best essays from each state contest are entered. The prizes in each state contest are inscribed certificates, books on chemistry and $120 in gold, and the prizes in the national contest are six four-year scholarships at any recognized college or university in the United States each providing tuition fees and $500 in cash annually. Thus the total value annually distributed to the winners of the high-school students' contest is approximately $29,000. Of the winners of the Garvan national scholarship prizes of the last six contests eleven have been graduated from college, twenty-four are now attending college and one will matriculate next fall. Our Committee conservatively estimates that 500,000 high-school students, ten per cent of the total enrolment, annually participate in the contest. The number of high schools which are requiring their students to participate and are giving credit for the essay work is increasing each year. The contest is growing steadily. The thinking chemistry teacher has recognized it as an attractive addition to the regular work because it provides a means for popularizing the study of chemistry.

Preliminary reports from the Chairmen of the fifty-one State and Territorial Committees on the result of the 1929–30 Contest, which closed to competitors on March 1st, show an increase of nearly twenty per cent in the total number of essays submitted. These essays are now undergoing examination by the various Committees in order to select the state prize winners, after which arrangements will be made for the public presentation of the prizes at the closing exercises of the winning schools.

The high-school contest has succeeded because of the unselfish cooperation of the chemistry teacher, the English teacher, school officials, and the professional and lay members of the State Committees, all of whom have willingly contributed their time and effort in an endeavor to arouse the students and their parents to a realization of the vital place which the science of chemistry occupies in their existence.

Normal School and Teachers' College Contest

Students representing forty-five normal schools and teachers' colleges participated in the 1929–30 contest. This is an appreciable increase over last year, and a remarkably good showing in view of the fact that many of the 252 schools in the normal school group offer no chemistry. Our Committee feels that because a majority of students attending normal schools and teachers' colleges go into the teaching field immediately on graduation, it is highly important that they be afforded the opportunity to acquire an understanding of some of the fundamental facts of chemistry which they are bound to do in the course of preparing an essay on one of the topics of our contest. Such of these schools as do offer chemistry coöperate most willingly in the contest work. The prizes in this contest are six of $500, six of $300, and six of $200, and the winners for 1929–30 appear on pages 1177–8 of this issue.

University and College Freshman Contest

One hundred and eighty-nine colleges and universities are represented in the 1929–30 freshman contest. This is an increase over last year of twenty participating institutions. The contest again enjoyed the active coöperation of the chemistry departments and many of the English departments of the institutions represented. These institutions are continuing to give credits for the essays prepared for the contest, thus providing an additional incentive to the students to do their best possible work with the essays. Our Committee is deeply indebted to the teachers in charge of freshman chemistry for the whole-hearted manner in which so many of them have fitted the essay writing into their courses. The Committee feels that this essay work has a logical place in the student's first-year work at college and is a necessary part of his cultural training. The prizes in this contest are six of $500, six of $300, and six of $200, and the names of the winners for 1929–30 appear on pages 1176–7.

The envelope system of identification was employed in all three essay contests this year and has received the commendation of the State Committees, teachers, and students alike.

Hon. Ray Lyman Wilbur, Secretary of the Interior, has succeeded Herbert Hoover as Chairman of our National Awards Committee. Mr. Hoover acted as Chairman for six years, relinquishing the post on entering the White House on March 4, 1929.

XUM

WINNERS OF PRIZE ESSAY CONTEST, 1929–1930*

COLLEGE CONTEST

The Relation of Chemistry to Health and Disease

VERNON HARRY	University of Hawaii, Honolulu, T. H.	Synthetic Medicines	(1)
EMIL ZABELL	Ohio State University, Columbus, Ohio	Synthetic Medicines	(2)
GERTRUDE WESTMORELAND	Galloway Woman's College, Searcy, Ark.	Chemistry and Public Health	(3)

The Relation of Chemistry to the Enrichment of Life

MARION KATHLEEN FITCH	The College of Wooster, Wooster, Ohio	Chemistry as an Aid to Cultural Enjoyment	(1)
EDNA LUCILLE NELSON	University of Arkansas, Fayetteville, Ark.	Chemistry in the Preservation of Art Treasures	(2)
ROLAND EVES, JR.	University of Virginia, Charlottesville, Va.	Chemistry in the Preservation of Art Treasures	(3)

The Relation of Chemistry to Agriculture or to Forestry

CHARLES GERALD ALBERT	The College of Wooster, Wooster, Ohio	Utilization of Agricultural Wastes	(1)
MARY GARDNER WATSON	Goucher College, Baltimore, Md.	The Warfare of Chemistry against the Insect Foes of Agriculture	(2)
HELEN HARDT SEATON	Sweet Briar College, Sweet Briar, Va.	Utilization of Agricultural Wastes	(3)

The Relation of Chemistry to National Defense

EUGENE EDWARD SENSEL	Oberlin College, Oberlin, Ohio	Is the Use of Gas in Warfare Justifiable?	(1)
JOHN L. BRUNER	Hampden-Sydney College, Hampden-Sydney, Va.	Is the Use of Gas in Warfare Justifiable?	(2)
LANDON BOTELER BACKUS	University of Maryland, College Park, Md.	Chemistry in the Prevention, Detection, and Prosecution of Crime	(3)

The Relation of Chemistry to the Home

JEAN MARIE BROWN	St. Elizabeth College, Convent Station, N. J.	Chemistry and Esthetics in the Home	(1)
JOHN A. YOURTEE	University of Maryland, College Park, Md.	Chemistry and Household Conveniences	(2)
RUTH ALLEN HUNT	University of Maryland, College Park, Md.	Chemistry as a Factor in the Economics of the Home	(3)

* National high-school awards have not yet been made.

The Relation of Chemistry to the Development of an Industry or a Resource of the United States

HENRY LEVIN	Armour Institute of Technology, 33rd St. & Federal St., Chicago, Ill.	The Relation of Chemistry to the Refining of Oil	(1)
JAMES M. CREAGAN	Grand Rapids Junior College, Grand Rapids, Mich.	The Contributions of Chemistry to Aerial Transportation	(2)
WILLIAM ALFRED FOWLER	The Ohio State University, Columbus, O.	Chemistry, The Salvager	(3)

NORMAL SCHOOL AND STATE TEACHERS' COLLEGE CONTEST

The Relation of Chemistry to Health and Disease

VIVIAN M. SCOWDEN	Slippery Rock State Teachers' College, Slippery Rock, Pa.	Chemistry in Relation to Health and Disease—Immunity	(1)
GUY E. MILLS	Slippery Rock State Teachers' College, Slippery Rock, Pa.	Relation of Muscle Work to Energy Exchange	(2)
ALFRED J. MILLET	Plattsburg State Normal School, Plattsburg, N. Y.	The Relation of Chemistry to Health and Disease	(3)

The Relation of Chemistry to the Enrichment of Life

EARDLEY B. MADSEN	Snow College, Ephraim, Utah	Chemistry in Relation to the Enrichment of Life	(1)
LORA WEBB	Louisiana State Normal College, Natchitoches, La.	Chemistry in Relation to the Enrichment of Life	(2)
APHRODITE FLAMBOURA	Chicago Normal College, 68th & Stewart Ave., Chicago, Ill.	The Relation of Chemistry to the Enrichment of Life	(3)

The Relation of Chemistry to Agriculture or to Forestry

ROBERT G. BICKEL	State Teachers' College, West Chester, Pa.	The Relation of Chemistry to Agriculture	(1)
OPAL SNYDER	Asheville Normal School, Asheville, N. C.	Relation of Chemistry to Agriculture	(2)
JESSIE JOY	Nebraska State Teachers' College, Peru, Neb.	Nitrogen—How Obtained and Its Relation to Agriculture	(3)

The Relation of Chemistry to National Defense

FRANKLIN M. BLEVINS	Arkansas State Teachers' College, Conway, Ark.	Chemistry in Relation to National Defense	(1)
MAX E. THOMPSON	Western Illinois State Teachers' College, Macomb, Ill.	Retorts and Armageddon	(2)
VERNE K. FLETCHER	Louisiana State Normal College, Natchitoches, La.	The Relation of Chemistry to National Defense	(3)

The Relation of Chemistry to the Home

RUTH FOSTER	Oregon Normal School, Monmouth, Ore.	The Relation of Chemistry to the Home	(1)
LILLIAN COX	Eastern Kentucky State Teachers' College, Richmond, Ky.	The Relation of Chemistry to My New Kentucky Home	(2)
MARIAN PENROSE	Arkansas State Teachers College, Conway, Ark.	Chemistry in Relation to the Home — Living from Test Tubes	(3)

The Relation of Chemistry to the Development of an Industry or a Resource of the United States

CLETIS J. LITTLE	Eastern Illinois State Teachers' College, Charleston, Ill.	The Relation of Chemistry to the Textile Industry	(1)
FRANCES AGNES EDWARDS	Fredericksburg State Teachers' College, Fredericksburg, Va.	Chemistry in Relation to Paper Making	(2)
DEANE T. DORWIN	Ball State Teachers' College, Muncie, Ind.	The Relation of Chemistry to the Development of an Industry	(3)

Wood Flour Opens New Field for Industry. Industrial plants in the United States are developing over night new uses for wood flour, according to the National Committee on Wood Utilization of the Department of Commerce. Wood plastics of the type that can be pressed or molded are now working into specialized fields, where apparently their use is meeting an economical approval. Only recently have wood plastics entered the furniture and other industries.

The committee stated that it is impossible to tell exactly the amounts of wood flour consumed by various industries. Phenol-resin products, linoleum and its use in dynamite cartridges as filler consume many thousands of pounds yearly. The increasing demand for wood flour in the manufacture of various articles has resulted in an increased consumption of the product from 7000 tons in 1924 to 24,000 tons in 1927, and approximately 40,000 tons in 1928. During 1928 imports of wood flour into the United States totaled 14,490,401 pounds, valued at $94,723, it was stated.

It was pointed out by the committee that whereas American operators are spending money to dispose of sawdust and shavings, European lumber manufacturers are converting these materials into wood flour, exporting it to this country, paying duty, and evidently selling it at a profit. European wood flour has been claimed to have certain advantages over the domestic product, but the validity of the claim has been disproved, it was stated. Increased experience and care in the selection of raw material by American manufacturers have resulted in a product equal in every way to that produced by foreign mills, according to the committee.

The wood substance of various species of trees differs very little in composition, it was explained. However, there are certain infiltrations of gums and resins in some woods, and in others certain coloring, that preclude their use as wood flour for some products.

Spruce, fir, and pine are the chief woods used in Europe to produce the highest grades of wood flour. Similar species are represented in the United States by true firs, white pines, and spruces.—*Ind. Eng. Chem.*

Correspondence

WILHELM OSTWALD—A CORRECTION

Permit me to call your attention to a mistake in the April issue of the JOURNAL.

In the Editor's Outlook on Wilhelm Ostwald, it is stated: "Ostwald received his early training in the Polish City of Riga."[1]

Riga is the capitol of Latvia and the Letts and never was a Polish city. Until the great war Latvia was a part of Russia.

E. R. SCHULZ

THE PATENT CEREALS CO.,
GENEVA, NEW YORK

Editor's Note: The information referred to was taken from the book, "New Era in Chemistry," by H. C. Jones, D. Van Nostrand Co., New York City, **1913,** p. 172.

[1] THIS JOURNAL, **7,** 731 (Apr., 1930).

PRACTICAL LABORATORY TRAINING

In the March issue of THIS JOURNAL is an article on the recovery of iodine.[1] The enclosed paper[2] on the same subject just naturally ran off my typewriter when I read the method to convert the iodine into its salts.

Why all the textbooks still give the methods of 80 years ago is what no fellow can understand. Teachers seem in a rut, and the poor students are worse confounded. My standpoint is making over a stony Connecticut farm into a real home, and letting chemistry go hang. But I read the JOURNAL from cover to cover every month and feel depressed generally at the indifferent results in training the students.

There are always some rays of hope, however. One of the best things in the JOURNAL, in my humble opinion, appeared some months ago. The article illustrated a very practical set-up for the manufacture of coal gas.[3] A series of such articles, using plumber's fittings, etc., resembling the commercial plant as much as possible would not look so difficult to the beginner, who usually, at first, looks upon the laboratory apparatus

[1] Bonner and Masaki, "The Recovery of Iodine as Sodium Iodide from Waste Iodide Solutions," THIS JOURNAL, **7,** 616–7 (Mar., 1930).

[2] See this issue, pages 1131–4.

[3] Howard Williams, "A Working Model By-Product Coke Plant. A Chemistry Project for a Student at the Secondary Level," *Ibid.*, **6,** 745–52 (Apr., 1929).

as something quite magical, the meaning of which is almost impossible to grasp. It is something solid and practical that he needs to go with his as yet untrained hands. Therefore, as I say, preparations in apparatus not associated with classroom chemistry do not automatically close the mind, as Wilson said, against the introduction of knowledge, but allow him to grasp the experiments as an every-day matter. Your "What Is Wrong with the Picture?" shows this difficulty plainly.

Of course, it is only the enthusiast who may work these ideas out, but, thank goodness, there are such, and in this connection I will, if I may, give $10.00 for you to give to the student author of a good illustrated description, in the JOURNAL, of a good model. What about a Townsend chlorine cell, Solvay, LeBlanc, lead chamber sulfuric acid or other plant for a start?

And so may the adventurous chemist be trained, who with a meager assay outfit can recover his supplies or prepare some of them from the materials found locally. In the western deserts, old tin cans found on the camping sites near water holes can be used to separate the salts found on the near-by flats by fractional crystallization. Even the percentages of half a dozen components can be worked out to tolerable accuracy. A wood fire burnt to live coals, when the sun is not blazing, clay, water, and a few old tomato cans and brains will do wonders.

Even many an ignorant desert "rat," with a little mercury to amalgamate his scarce poor ore, will scoop a hole in a raw potato, poke in the amalgam, bake it over the dying embers while he smokes his pipe and hears the coyotes begin their nightly howl. By skilful carving the old hand distils most of his mercury for re-use, and the lacy gold may purchase a "good time" or be transmuted into flour and bacon to keep up the quest for gold, if not for knowledge.

REDDING RIDGE
BETHEL, CONNECTICUT

ERNEST MACKENZIE MARSHALL

THE STRUCTURE OF MATTER: BALANCING OXIDATION-REDUCTION EQUATIONS

My dear Mr. Reinmuth:

I have just been reading your series of articles on "The Structure of Matter"[1] and am trying the electron story with my pupils. But I am puzzled how to apply it in oxidation reductions involving radicals.

Would you say that sulfur has a valence of four in SO_4^{--}? Or that chlorine has a valence of three in ClO_3^-? (Calculating each shared elec-

[1] THIS JOURNAL, **5**, 1152–63, 1312–20, 1473–9, 1639–46 (1928); **6**, 117–22, 341–8, 527–35 (1929).

tron pair as a valence bond.) Wouldn't most non-metals have a valence of four?

I have just finished your article in the March, 1929, JOURNAL.[2] Thought I saw light, but apparently not enough, for am stuck on the old favorite: $3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$.

How do you decide the number of electrons gained or lost in these cases? Why not write: $MnO_4^- \longrightarrow Mn^{++} + 4O$? Will you explain in detail some of these equations and how electrons are of use in writing them?

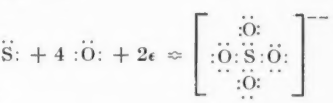
G. A. C.

Dear Sir:

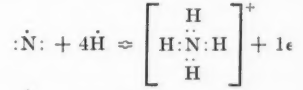
Your letter of the 21st is at hand and I shall attempt to offer you what suggestions are possible within the rather limited compass of a letter.

The matter of valence is always puzzling, particularly in view of the fact that there is no universally accepted definition of valence. I have discussed this problem at some length in the latter half of the third article of the series on "The Structure of Matter." See pp. 1476–9, November, 1928. (Incidentally, the first word in the second line on p. 1479 should be *tetravalent* rather than *tervalent*.)

Personally I find it best to avoid attempting to ascribe valences to the individual atoms in an ion. The ion as a whole has a valence, which is easily determined by counting the number of electrons which the atoms would have in the uncombined state and comparing it with the total number of electrons in the ion.[3] Thus the SO_4 ion has two more electrons than an atom of sulfur and four atoms of oxygen would have; consequently its valence is -2.



On the other hand, the ammonium ion has one less electron than an atom of nitrogen and four atoms of hydrogen; its valence is $+1$.

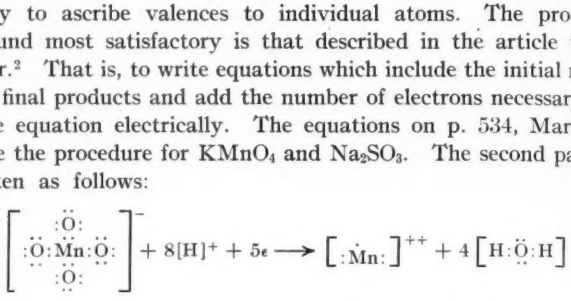


When the ion goes through a reaction unchanged no complications

[2] THIS JOURNAL, **6**, 527–35 (Mar., 1929).

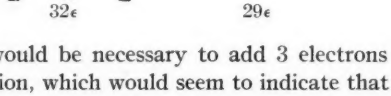
[3] This point of view leads to two definitions of valence. In non-ionic compounds the valence of an atom is the number of electron pairs shared with other atoms. The valence of an ion is its electrical charge. As applied to individual atoms in ions, the term is meaningless.

arise. When the ion takes part in an oxidation reduction it is still unnecessary to ascribe valences to individual atoms. The procedure I have found most satisfactory is that described in the article to which you refer.[2] That is, to write equations which include the initial reactants and the final products and add the number of electrons necessary to balance the equation electrically. The equations on p. 534, March, 1929, illustrate the procedure for $KMnO_4$ and Na_2SO_3. The second pair might be written as follows:



A count of the electrons on each side of the respective equations above makes it obvious why the balancing must take place as indicated in the article.

There are two objections to writing $MnO_4^- \longrightarrow Mn^{++} + 4O$. The first is that $KMnO_4$ does not yield "nascent" (or atomic) oxygen. The second objection is that the equation as written is not balanced electronically.



To balance, it would be necessary to add 3 electrons to the right-hand side of the equation, which would seem to indicate that the permanganate ion has a reducing power of 3, rather than an oxidizing power of 5, as it actually has.

I believe that the best way to determine the number of electrons gained or lost is to diagram the equations as I have done here and to count the number of electrons necessary to balance. It cannot be too strongly emphasized, however, that one must first know the actual reactants and the reaction products before one can balance equations by any system. The electronic system is no exception in this respect.

It is well to keep in mind the fundamental principles that oxidation represents a loss of electrons, reduction a gain of electrons; an oxidizing agent must be reduced and hence must operate, either by itself or in coöperation with some other agent, as an acceptor of electrons; a reducing agent must give up electrons. Paradoxical as it may seem, the permanganate ion acts in conjunction with the hydrogen ion as an electron

"sink." The equation, $MnO_4^- + 8H^+ + 5\epsilon \longrightarrow Mn^{++} + 4H_2O$, takes account of that fact.

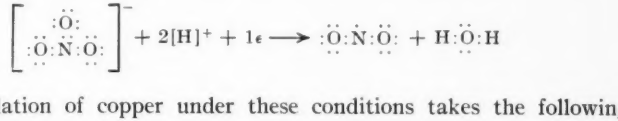
It is, then, a general rule that in any properly written and properly balanced partial electronic equation, the electrons added for the purpose of balancing must appear as positive quantities on the same side of the equation as the oxidizing agent. When placed on the same side of the equation as the reducing agent, they must appear as negative quantities.

As further examples, let us consider the respective reactions of dilute and concentrated nitric acid with metallic copper.

The nitric ion is capable of undergoing a number of different reductions depending upon the nature of the other reactants present, the concentrations of the reactants, the temperature, etc. The reduction of the nitric ion in concentrated nitric acid by metals takes the following course:

$$NO_3^- + 2H^+ + 1\epsilon \longrightarrow NO_2 + H_2O \qquad (1)$$

This may, of course, be written:



The oxidation of copper under these conditions takes the following course:

$$Cu^\circ - 2\epsilon \longrightarrow Cu^{++} \qquad (2)$$

which may be written:

$$[:Cu] - 2\epsilon \longrightarrow [Cu]^{++}$$

Equations (1) and (2) above are therefore our electronically balanced, partial equations for the reduction of NO_3^- ion and the oxidation of Cu°, respectively. Since equation (2) involves twice as many electrons as equation (1) we must multiply equation (1) by two before adding the partial equations together.

$$\begin{array}{r} 2NO_3^- + 4H^+ + 2\epsilon \longrightarrow 2NO_2 + 2H_2O \\ Cu^\circ - 2\epsilon \longrightarrow Cu^{++} \\ \hline Cu^\circ + 2NO_3^- + 4H^+ \longrightarrow Cu^{++} + 2NO_2 + 2H_2O \end{array} \qquad (3)$$

The sum, equation (3), is a completely balanced ionic equation for the actual reactants. If we desire to convert this into a molecular equation it is necessary to add to each side of the equation the two NO_3^- ions which go through the reaction unchanged.

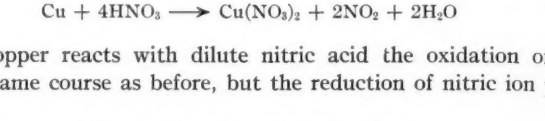
$$\begin{array}{r} Cu^\circ + 2NO_3^- + 4H^+ \longrightarrow Cu^{++} + 2NO_2 + 2H_2O \\ 2NO_3^- \longrightarrow 2NO_3^- \\ \hline Cu^\circ + 4NO_3^- + 4H^+ \longrightarrow Cu^{++} + 2NO_3^- + 2NO_2 + 2H_2O \end{array} \qquad (4)$$

Equation (4) is easily assembled into the familiar molecular equation (5).

$$Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O \qquad (5)$$

When copper reacts with dilute nitric acid the oxidation of copper takes the same course as before, but the reduction of nitric ion proceeds as follows:

$$NO_3^- + 4H^+ + 3\epsilon \longrightarrow NO + 2H_2O \qquad (1A)$$



Multiplying the partial equations by appropriate factors and adding, we arrive at equation (3*A*) as follows:

$$2NO_3^- + 8H^+ + 6\epsilon \longrightarrow 2NO + 4H_2O$$

$$3Cu^\circ - 6\epsilon \longrightarrow 3Cu^{++}$$

$$3Cu^\circ + 2NO_3^- + 8H^+ \longrightarrow 3Cu^{++} + 2NO + 4H_2O \qquad (3A)$$

To convert to the molecular equation we must add six NO_3^- ions to each side of the equation.

$$3Cu^\circ + 2NO_3^- + 8H^+ \longrightarrow 3Cu^{++} + 2NO + 4H_2O$$

$$6NO_3^- \longrightarrow 6NO_3^-$$

$$3Cu^\circ + 8NO_3^- + 8H^+ \longrightarrow 3Cu^{++} + 6NO_3^- + 2NO + 4H_2O \qquad (4A)$$

$$3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O \qquad (5A)$$

You will find a number of other specific examples in the two articles by E. R. Jette and V. K. LaMer, THIS JOURNAL, **4**, 1021–30 (Aug., 1927); 1158–67 (Sept., 1927).

OTTO REINMUTH, *Associate Editor*

PHARMACOPEIA ANALYSES FOR MEDICAL STUDENTS

Sarver[1] has presented an interesting discussion of some problems in connection with quantitative analysis for pre-medical students. We have been solving some of these problems for about ten years by using the United States Pharmacopeia.

The Pharmacopeia is a treatise that is only too little known by chemists. The methods of the Pharmacopeia have been selected with great care, practically all of them have the merit of being simple, accurate, well tested, and of being "official." The pre-medical student becomes ac-

[1] THIS JOURNAL, **7**, 365–6 (Feb., 1930).

quainted with the use of the book, and with the analysis of substances which are largely used in medicine. Most of the methods are volumetric.

Our pre-medical students make Pharmacopeia analyses of acetic acid, ammonia water, hydrogen peroxide, ferric chloride solution, and Fowler's potassium arsenite solution. It will be noted that these exercises involve titration with standardized base, acid, potassium permanganate, sodium thiosulfate, and iodine, respectively.

DICKINSON COLLEGE
CARLISLE, PENNA.

E. A. VUILLEUMIER

Increase in Cures of Bone Cancer Due to X-Rays. Great increase in the number of cases "cured" of bone cancer in recent years was attributed by Dr. Joseph Colt Bloodgood of Baltimore to X-rays and to popular education in their value. Dr. Bloodgood recently addressed the Radiological Society of North America. He and Dr. Russell L. Haden of Kansas City received the society's gold medal for their work with X-rays.

"Before the discovery of the X-rays there was rarely if ever a verified cancer of bone cured by amputation," Dr. Bloodgood said. "Since the discovery of the X-rays and up to 1921 the actual cures of cancer of bone, in the records of The Johns Hopkins Hospital Surgical Pathological Laboratory, were four per cent. Today, now that more people know the importance of an immediate examination after the slightest warning or injury to a bone, the curves have increased to thirty-five per cent."

Over one-third of the persons treated at the hospital for bone cancer since 1921 have lived for at least five years without any recurrence of the disease. Apparently they have been "cured."

The warnings of cancer of the bone are not different from the warnings of troubles of the bone that are not cancer, Dr. Bloodgood said. Pain or discomfort of some kind, swelling or slight loss of function should be investigated immediately and X-ray examination should be part of the investigation. This is particularly important after accidents or injuries, even if no break in the bone is apparent. Slight breaks and injuries of bones can be disclosed by the X-ray which, if undiscovered and untreated, might lead to serious trouble later on, Dr. Bloodgood warned.—*Science Service*

Rare Sugar Now Made Cheaply from Cotton-Seed Hull Bran. Xylose, a sugar so rare that it has heretofore been a laboratory curiosity at $100 a pound, can now be turned out cheaply at a few cents a pound, requiring no raw material other than waste cotton-seed hull bran, water, and sulfuric acid. At the recent meeting of the chemistry section of the American Association for the Advancement of Science at Ames, Iowa, Warren E. Emley of the U. S. Bureau of Standards described the process by which seed waste is changed into sugar.

Xylose is different from its nearest neighbors in the sugar world, the hexoses or glucose-type of sugars, in that it contains five carbon atoms to the molecule instead of six. Because it has always been so rare and expensive, it has never been possible to perform any extensive experiments with it, and consequently it has no known uses. But the experimental plant at Anniston, Ala., can turn out a hundred pounds a day, and when larger units are built they will have an annual production of about a million tons of cotton-seed hull bran to work on. So that if xylose has any uses it should not take long now to discover them.

Mr. Emley suggested that it might be used directly in food products, or possibly industrially as a raw material for alcohol, acids, and other chemicals.—*Science Service*

Chemical Digest

BRIGHTER CHEMISTRY

The following review of Professor James Kendall's recent book[1]*—"At Home among the Atoms"—is such delightful reading that we are printing it here in full. This review by John Read appeared in a recent issue of Nature.*[2]

Some one has spoken of chemistry as a science of symbols, and in a sense the illusion is apt, since a skilful system of symbolic representation has lightened the labors of the chemist as much as the wonderful decimal notation has shortened the processes of the mathematician. The peculiar force of a paradox is therefore lent to the reflection that this prime clarifying influence of modern chemistry is a direct outcome of the obscurantism of medieval alchemy. From very early times, indeed, chemistry has been closely bound up with symbolism and mysticism: in ancient Egypt a knowledge of chemical secrets was the jealously guarded prerogative of priests and kings; and at a later day the "sons of Hermes" enmeshed their "precious pearls" of alchemy in a web of enigma, cryptogram, and obscure expression which maintained the high standard of unintelligibility of their patron's famous Smaragdine Table.

Thus, in his "Cours de Chymie," published in 1675, Nicolas Lémery had ample reason to complain that "la plûpart des auteurs qui ont parlé de la Chymie, en ont écrit avec tant d'obscurité, qu'ils semblent avoir fait leur possible pour n'être pas entendus." Lémery himself was so successful in stripping chemistry of its mysticism that he produced a comprehensive and intelligible textbook which may be read with pleasure even at the present day. So the "Cours de Chymie," which for the first time presented the naissant science to the world in all its native simplicity, became literally a "best-seller" of the seventeenth and eighteenth centuries; it passed through numerous editions in various languages, and held its place as the authoritative work on chemistry until the time of Lavoisier.

The epoch-making "Traité élémentaire de Chimie," published in 1789 swept away the last remnants of mysticism; while Dalton's "New System of Chemical Philosophy" afforded an indication, some twenty years later, of the coming resurgence of symbolism in the cause of progress. Since the birth of the atomic theory there have been innumerable works dealing with the rapidly expanding science from various points of view, and ranging in size and cost from the lordly and misnamed "handbooks" of Beilstein and others to plebeian sixpenny primers. Lémery, as we have seen,

[1] See THIS JOURNAL, **6**, 2065–6 (Nov., 1929).

[2] *Nature*, **125**, 155–7 (Feb. 1, 1930).

presented his information in an attractive form. He had, in the words of Hoefer, "le talent de décrire les choses les plus obscures et les plus arides avec une simplicité et une précision remarquables." Unfortunately, the same cannot be said of some of his successors; for, on the whole, chemical writers have become more formal and arid as knowledge has accumulated.

In the early days of the atomic theory, however, popular expositors of the science were not wanting. Among such writers we may well pause to pay a tribute to Jane Marcet and John Scoffern: for how many contemporary students of chemistry have so much as heard their names. Jane Marcet's "Conversations on Chemistry" first appeared in 1805, and ran through many editions during the succeeding fifty years. The text took the form of a conversation between a certain Mrs. B. and her two pupils, Caroline and Emily.

"To confess the truth, Mrs. B.," says Caroline boldly, at the outset, "I am not disposed to form a very favorable idea of chemistry, nor do I expect to derive much entertainment from it. I prefer the sciences which exhibit nature on a grand scale, to those that are confined to the minutiae of petty details. . . . I grant, however, there may be entertaining experiments in chemistry, and should not dislike to try some of them: the distilling, for instance, of lavender, or rose water. . . ."

In countering this frank avowal, Mrs. B. points out that Caroline's "want of taste" for chemistry is a consequence of her limited ideas. "You confine the chemist's laboratory to the narrow precincts of the apothecary's and perfumer's shops, whilst it is subservient to an immense variety of other useful purposes. Besides, my dear . . . nature also has her laboratory, and there she is incessantly employed in chemical operations. You are surprised, Caroline; but I assure you that the most wonderful and the most interesting phenomena of nature are almost all of them produced by chemical powers."

If modern ambition should feel disposed to mock such useful pioneering toil, it suffices to quote a passage from one of Faraday's letters:

> "Mrs. Marcet was a good friend to me," he wrote to de la Rive, "as she must have been to many of the human race. I entered the shop of a bookseller and bookbinder at the age of 13, in the year 1804, remained there eight years, and during the chief part of the time bound books. Now it was in those books, in the hours after work, that I found the beginning of my philosophy. There were two that especially helped me, the *Encyclopaedia Britannica*, from which I gained my first notions of electricity, and Mrs. Marcet's *Conversations on Chemistry*, which gave me my foundation in that science. . . . You may imagine my delight when I came to know Mrs. Marcet personally; how often I cast my thoughts backwards, delighting to connect the past and the present; how often, when sending a paper to her as a thank-offering, I thought of my first instructress, and such like thoughts will remain with me."

Scoffern's "Chemistry No Mystery," published in 1839, is one of the few scientific books containing illustrations by Cruikshank, who made

great play in it with the effects of laughing gas and sulfuretted hydrogen. The frontispiece, entitled "Laughing Gas," has a truly Pickwickian motif: "Some jumped over the tables and chairs; some were bent upon making speeches; some were very much inclined to fight; and one young gentleman persisted in an attempt to kiss the ladies." Moreover, the harrowing story of the lady "made beautifully white" with a preparation of the metal bismuth, who "took a bath in the Harrowgate waters, when her fair skin changed in an instant to the most jetty black," would have made a notable addition to the repertoire of Sam Weller. In this entertaining and informative work, chemistry is ably expounded in a series of twenty-one lectures. The author's point of view is explained in the following remarks addressed to his "dear young friends" in the opening lecture:

> "You think," he says, "that young people cannot possibly engage themselves in the study of a science which has been cultivated by such great men as Sir Humphry Davy and Doctor Wollaston—this supposition is wrong. I grant that the very highest order of intellect is often required to make a discovery; but when once made it may perhaps be rendered comprehensible to persons much younger than yourselves; and indeed I cannot think of any necessary portion of chemical science which does not admit of a very easy and agreeable exemplification."

Like his predecessor, Lémery, Scoffern practiced what he preached.

These were joyous days for the "joyous science," for it was in the following year (1840) that Wöhler, writing under the significant name of S. C. H. Windler, published his pseudo-serious contribution to Dumas' ideas on "Substitution and the Theory of Types" in *Liebig's Annalen der Chemie und Pharmacie.*[3] To S. C. H. Windler's statement that "in the decolorizing action of chlorine, there is a replacement of hydrogen by chlorine, and that the fabrics which are now bleached in England according to the laws of substitution preserve their types," the genial Liebig, entering into the fun, added in an editorial footnote, "I have just learnt that there are already in the London shops fabrics of spun chlorine, much sought after in the hospitals and preferred to all others for nightcaps, etc."

Later in the nineteenth century, chemical literature relapsed into a severe formalism, which has been relieved only during the last few years by the appearance of a number of treatises designed to meet the needs of the growing popular interest in chemistry. The new movement toward a brighter chemistry has been borne along upon the wave of increasing interest in the human side of science, and has found its main expression among the English-speaking communities of the world. Prof. Kendall's book is an excellent example of this new tendency in the exposition of scientific facts and principles. Reducing, as he explains in his preface, the formal side of chemistry to a minimum throughout his treatment,

[3] See "The Theory of Types—A Satirical Sketch," H. B. Friedman, THIS JOURNAL, **7**, 633–4 (March, 1930).

Prof. Kendall develops in a logical and systematic manner the meaning of substances, elements, atoms, and other fundamental chemical conceptions. Having brought us by pleasant ways into the atomic Lilliput, he proceeds to put us "on really intimate terms" with such prominent Lilliputians as oxygen ("the working-girl—Heaven has already protected her"), hydrogen ("nice baby"), and chlorine ("gentlemen prefer blondes"). Later he conducts us around the apartment house of Mendeléeff Court, pausing *en route* to relate to his party the story of young Newlands and "the dear old Tories of the London Chemical Society."

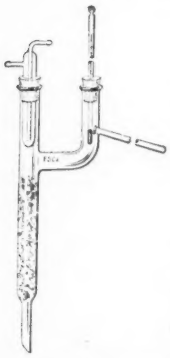
On the first floor we meet the metals of the alkali family; on the second, we hear of radioactivity, discover that the alchemists were fundamentally right, and rewrite the constitution; on the third, we are told in an impressive stage-whisper that "Al's here;" and eventually we wander out into the country and explore the intriguing mazes of Bohrville. The whole itinerary is enlivened by interesting glimpses of the human and historical side of the subject (including, we are glad to note, a quotation from Mrs. Marcet); while the dark places are unfailingly illuminated by flashes of humor, dashes of picturesque phraseology, and telling illustrations from the things and doings of every-day life; the book also contains numerous explanatory diagrams and plates. "Read Sir John Mandeville's Travels to cure you," was the advice of Charles Lamb; the convalescent of a later and more scientific age may be recommended to join a Prof. Kendall's personally conducted tour among the genuine marvels of the atomic world.

Up to the present, the revivification of chemical literature has not extended to the periodicals, and if we suggest that circulation of any one of our standard chemical journals would increase by leaps and bounds if only every hundredth communication were written by a modern S. C. H. Windler, we may perhaps anticipate a reply from "the dear old Tories" in the sense of the concluding words of the excellent Scoffern: "As a young lion torn from the forest is tame and playful, allowing caresses, and joining in every frolic, so we found chemistry; but as it grew up to its full size and strength, it became a thing no longer to be played with; demanding all care, attention, and respect."

Prize Awards in Chemistry of the Paris Academy of Sciences. The *Montyon prize* (unhealthy trades) to DANIEL FLORENTIN, for his work on the hygiene of large towns; the *Jecker prize* between RICHARD FOSSE, for his work in agricultural, biological, and organic chemistry, and MARCEL SOMMELET, for the whole of his work in organic chemistry; the *Cahours foundation* between HENRI MOUREU, for his researches on the tautomerism of the α-diketones, and RAYMOND QUELET, for his work on certain derivatives of benzene; the *Houzeau prize* to ANDRÉ TRAVERS, for his work in inorganic and analytical chemistry.—*Nature*

ABSTRACTS

APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS



DISTILLING COLUMN WITH COLD-SPOT CONDENSER AND INSET DELIVERY TUBE

Some New Technic in Fractionating. *Laboratory*, **3**, 12 (1930).—Projecting the side arm into the distilling flask prevents heavy ends flowing from the side walls into the distillate. The use of a cold spot condenser (see Figure) permits temperature control at the top of the column; columns so equipped permit cuts to $^1/_{10}$ degree C.

H. H. K.

LESSING (NON-PACKING) CONTACT RINGS ($^1/_4$-INCH)

Close Fractions with the Lessing Contact Ring. *Laboratory*, **3**, 13 (1930).—The rings have the advantage over glass beads in that they expose greater surface; occupy less volume per unit; and have a free vapor space of 87%.

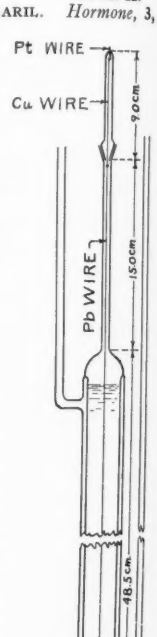
H. H. K.

The Wurtz Distilling Tube. O. L. BARIL. *Hormone*, **3**, 117–8 (Nov., 1929).—A comparison between the Wurtz three-bulb distilling tube with various fillings, an ordinary distilling apparatus, and a Young four-pear still was made to determine the maximum efficiency in fractionating a mixture of 25 cc. of 95% ethyl alcohol and 25 cc. distilled water. Short glass tubes were found to be much more efficient than glass beads or glass wool as a packing for the bulbs. Most efficient recovery was obtained with the Wurtz tube in which the two lower bulbs were packed with glass tubes.

BYCK

A Laboratory Ozonizer. A. L. HENNE. *J. Am. Chem. Soc.*, **51**, 2676–7 (Sept., 1929).—The paper describes a laboratory ozonizer, a simplified modification of one described previously by Smith [*J. Am. Chem. Soc.* **47**, 1844 (1925)].

Modifications eliminate mercury which makes apparatus heavy and liable to breakage, simplifies glass-blowing requirements, permits use of H_2SO_4 as electrode, and eliminates litharge joints. All of these improvements substantially decrease the cost. The figure is self-explanatory.



A lead wire dipping into dilute sulfuric acid is used as one electrode. The lead wire (six strands of fuse wire twisted together) remains straight and centered by its own weight so that sparking is prevented. As in Smith's, three tubes are sealed in series and immersed in water in a battery jar. The water is a second electrode and acts as a cooling bath. Since no mercury is used, the weight of the tubes is almost equal to the displaced water so that only the simplest support is needed to hold the tubes upright in the water bath. 10,000 volts is supplied across the electrodes from a $^1/_4$-kw. transformer. Maximum cost is as follows. Transformer $10, battery jar $7, material and labor for three tubes $10.

It should be remembered that complete drying of the oxygen is an important feature. Yields of ozone at different rates of input of oxygen are 14, 8, 3% with oxygen rates of 4, 2, 100 liters per hr.

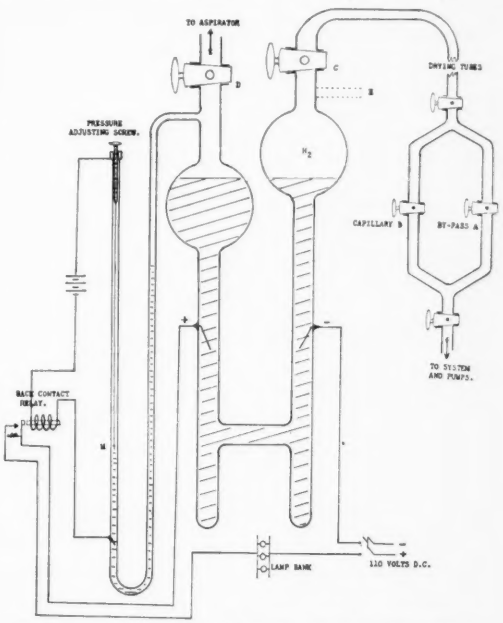
BYCK

A Laboratory Balloon Inflator. H. WILLIAMS. *Neo-Chemto-Ion*, **3**, 12–4 (Sept. and Dec., 1929).—In order to make a more lasting impression in the mind of the elementary student in some experiments on hydrogen, a demonstration of the lifting power of hydrogen-filled balloons was given. Ordinary toy rubber balloons were purchased and filled with hydrogen (prepared according to the standard experimental procedure) from a specially constructed inflator. A four-liter bottle is filled with hydrogen by displace-

ment of water. A two-hole rubber stopper is placed in the neck of the bottle, and a short glass tube passed through one hole. The balloon is fastened to the outer end of the tube. Through the other hole, a tube is passed leading to the bottom of the bottle. The other end of this tube is connected by rubber tubing to the laboratory water faucet. By turning on the water the hydrogen in the bottle is displaced with the rubber balloon under a pressure sufficient to overcome the elasticity of the balloon.

After tying the neck of the balloon and removing it from the glass tube from the bottle, a number of instructive experiments can be performed. The lifting power can be demonstrated, the balloon can be exploded by touching a candle to it, and numerous other phenomena can be strikingly demonstrated. BYCK

An Arrangement for Obtaining a Steady Flow of Gas at a Constant Low Pressure. F. G. SLACK. *Rev. Sci. Instruments* **1**, 33–5 (Jan., 1930).—"Two bulbs of approximately one liter capacity are sealed to the top of an ordinary electrolytic gas generator. One of these is connected through a stopcock to a storage and drying tube, thence to the main system via a short capillary sealed in the stopcock *B*, by-passed with the line containing stopcock *A* which may be opened for convenience in pumping out the system. The second bulb, used as a reservoir for the gas not desired, is connected through a stopcock to an aspirator or pump which is used to draw off the accumulation of gas from time to time. Also between this bulb and stopcock is attached a mercury manometer tube to indicate and regulate the pressure in the generator. The mercury column at *M* opens or closes a relay contact to start or stop the generation of gas. The entire system is of soft glass with platinum seal-ins for the electrodes. The complete system is mounted on a board 9″ by 60″ with holes cut for bulbs and stopcocks.



SCHEMATIC DIAGRAM OF APPARATUS FOR OBTAINING A STEADY FLOW OF HYDROGEN AT CONSTANT LOW PRESSURES

"The operation of the device is as follows; after filling to about the levels as shown in the figure with dilute electrolyte the pressure is reduced by alternately using the main pumps through the by-pass *A*, and the aspirator. Finally with the pressure of 1 or 2 cc. of mercury the liquid is drawn up to the stopcock *C* which is then closed. The generator is started and allowed to operate until the H_2 bulb is filled with gas, the oxygen being drawn off with the aspirator, if necessary to keep the desired pressure. After washing out the system several times with gas, the by-pass *A* is closed and the gas allowed to flow through the capillary *B* into the system. *B* consists of a fine capillary sealed with DeKhotinsky cement into the stopcock plug. It is not difficult to adjust the size of the capillary since the pressure may easily be adjusted by the variation of the generator pressure. In practice a second capillary of somewhat larger diameter has been placed on the pump side of the system to reduce the pressure gradient through the system. With the pumps operating continuously the pressure in the main system could be

quickly adjusted to any desired pressure between 0.001 mm. and 1.0 mm. of Hg or to even higher pressures, by simply varying the pressure in the generator. This pressure is first set approximately by means of the aspirator and then controlled by the pressure adjusting screw consisting of a brass screw several inches long passing a threaded collar. On the end of the screw is welded a platinum wire extending to the surface of the mercury. Fine adjustments may be made by this screw by regulating the height of the mercury column which backs up to the low pressure in the generator. Care must be used in opening the cocks *C* and *D* that the pressure outside the generator is approximately the same as that inside, to avoid forcing the liquid too rapidly in either direction. In case it is desired to use a commercial gas, this may be admitted to the system at *E* by an electrically controlled reducing valve or in small quantities by hand." R. L. H.

Disposition of Waste Sodium. T. L. KELLY. *Hormone*, **3**, 117 (Nov., 1929).—A method for the disposal of sodium waste, resulting from paring of the skin from pieces of the metal, is described. The sodium is thrown into a wide-mouth jar containing about $^7/_8$ kerosene and $^1/_8$ water. The sodium sinks in the kerosene until it strikes the interface between kerosene and water. The reaction liberates an amount of hydrogen which, adhering to the sodium, causes it to rise in the kerosene. After the hydrogen becomes discharged the sodium again sinks to the interface and the cycle is repeated. This method eliminates the use of alcohol and its subsequent recovery. It is a modification of the method for preparing carbonate free sodium hydroxide where in place of kerosene the distilled water is covered with a layer of ether, which excludes CO_2 and allows the metallic sodium to react with the water at a suitable and safe speed in the same way as in this method. BYCK

A New Method of Detecting Bromine and Iodine in the Presence of Each Other. F. HARMS. *Z. physik. chem. Unterricht*, **42**, 266 (Nov.-Dec., 1929).—The usual method for detecting iodine and bromine when they are both present is to precipitate the iodine by the addition of a little chlorine water, identifying it by shaking with carbon disulfide or carbon tetrachloride, oxidizing iodine to iodic acid by an excess of chlorine water and subsequent precipitation of bromine which can likewise be identified with the same organic solvents. The use of chlorine is not very pleasant on account of its odor. The following method seems to be better.

To the aqueous solution to be analyzed add a few drops of a solution of sodium hypochlorite which will liberate iodine but not bromine.

$$NaOCl + H_2O + 2\ KI = 2\ KOH + NaCl + I_2$$

Identify the iodine, if any, by shaking with chloroform which will turn violet. If iodine was found to be present add an excess of the solution of sodium hypochlorite and shake; this will decolorize the chloroform solution due to the oxidation of iodine to iodic acid.

$$I_2 + 5\ NaOCl + H_2O = 2\ HIO_3 + 5\ NaCl.$$

In order to detect bromine add now a little sulfuric acid.

$$2\ KBr + H_2SO_4 + NaOCl = K_2SO_4 + NaCl + H_2O + Br_2$$

If bromides are present the chloroform will turn brown on shaking. L. S.

How to Be Economical with Aqueous Solutions of Hydrogen Sulfide Which Is Not Used Regularly. S. GENELIN. *Z. physik. chem. Unterricht*, **43**, 29 (Jan.-Feb., 1930).—The preparation of aqueous solutions of hydrogen sulfide is not very pleasant. If this reagent is not used very frequently it is advisable to fill up the bottle completely with water whenever some of the solution has been taken out. The extent of dilution is much lower than the loss by oxidation in a flask containing air above the solution. L. S.

The Detection of Acetic Acid. D. KRUGER AND E. TSCHIRSCH. *Chem.-Ztg.*, **54**, 42–4 (Jan. 11, 1930).—The various methods suggested in the literature can be classified in the following manner: I. *Detection by Means of an Odor:* Odor of acetic acid. Odor of ethyl acetate. Cacodyl reaction. II. *Color Reactions:* Red coloration with ferric chloride solutions; blue coloration with *o*-phthalaldehyde and ammonia. III. *The Benedict Method.* IV. *Indirect Method:* The detection as acetone. V. *Methods Based on the Insolubility of Certain Acetates*, particularly the microchemical methods based on characteristic crystalline forms of certain acetates.

The authors discuss all of these methods and state that the first four are not very trustworthy. They suggest the detection of acetic acid by means of the microchemical determination of sodium uranyl acetate. They claim that this reaction is more sensitive than most microchemical reactions of acetic acid. The other microchemical methods—detection as silver, mercurous, cupric, or lead acetate—are not very sensitive because of the relatively large solubility of the acetates. L. S.

The Detection and Determination of Lead in Ethyl Gasoline. H. KIEMSTEDT. *Z. angew. Chem.*, **42**, 1107–8 (Nov. 30, 1929).—A number of suggestions have been made in the past: 1. Just acidify the gasoline with HCl and pass in H_2S. This method does not work at all. Lead triethyl chloride is formed and an ethyl group is split off which does not react with H_2S. 2. Remove the lead tetraethyl from the solution by subjecting the latter for several days to the action of sulfurous acid. The sulfur dioxide is absorbed by the lead tetraethyl with the formation of diethyl sulfonic acid and lead ethyl sulfinate. This method can be used but is not practical because of the length of time necessary. 3. Pass X-rays first through the solution and from there into an ionization chamber in which the air becomes more or less conducting depending upon the degree of adsorption. This method is interesting but it is an open question whether any other constituent of the gasoline would not seriously interfere with the results.

A simple method for the quick detection of lead is based on the unstability of lead tetraethyl in the light. Subject ethyl gasoline to the sunlight or a mercury vapor lamp and it will soon become cloudy and gradually small flakes will separate out. These flakes consisting mainly of lead oxide are easily dissolved in dilute acetic acid from which it can be identified in the standard way. The radiation method can be modified thus: wet a piece of filter paper with ethyl gasoline and dry it under the rays of the mercury vapor lamp. Wet it with dilute acetic acid and develop the paper by exposing it to H_2S or treating it with $(NH_4)_2S$, whereby it is turned brownish black due to the formation of PbS. Instead of H_2S or $(NH_4)_2S$ the paper can also be wetted with a dilute solution of KI by means of an atomizer, when the intensively yellow color of PbI_2 is produced. This test can be performed within a few minutes.

The following quantitative determination depends upon the reaction between lead tetraethyl and acetyl chloride in the presence of H_2O. The directions which have been worked out are as follows: Add 1 to 2 drops of H_2O and 2 to 3 cc. of acetyl chloride to 100 cc. of ethyl gasoline in a glass-stoppered, glass cylinder, shake, and let stand. The liquid becomes cloudy immediately; the red color changes to blue; voluminous white or light colored flakes precipitate. The decomposition of the lead tetraethyl is complete after 3 to 4 hours. Filter off the decolorized benzine. Collect the precipitate on a filter paper, wash several times with petroleum ether, dissolve the lead in dilute nitric acid and precipitate it in the known manner, *e. g.*, as a sulfate by evaporation with sulfuric acid.

Good checks can be obtained. An English product examined in the above manner showed 0.07 g. lead per 100 cc. of the ethyl gasoline having a specific gravity of 0.732 at 15° equivalent to 1.01 g. lead per kg. L. S.

The Uses of Sodium Thiosulfate in Analytical Chemistry. See this title on page 1197.

Quantitative Chemical Spectroscopy. *Laboratory*, **3**, 5–7 (1930).—The first of a series of articles which describes a spectrograph suitable for determining minor constituents in an analysis. H. H. K.

Gas Calorimeters. *Instruments*, **3**, 82–99 (Feb., 1930).—A description of the various types of gas calorimeters with illustrations. H. H. K.

Bomb Calorimeters. *Instruments*, **3**, 99–113 (Feb., 1930).—A description of the various types of bomb calorimeters with illustrations. H. H. K.

Calorimetry in America. See this title on page 1199.

Calorimetry, Its Importance and Practice in the Gas Industry. See this title on page 1194.

Calorimetry. W. BLOCK. *Instruments*, **3**, 123–8 (Feb., 1930).—A brief elementary description of the methods used in determining heating values of various fuels. H. H. K.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS

Arousing Interest in Chemistry. B. F. LAMONT. *High Sch. Teacher*, **6**, 56–7 (Feb., 1930).—Interest is essential to mastery. Results commensurate with the varied student abilities should be expected and such outcomes are only possible where there is interest.

As aids to interest—creation, project posters, simple analysis, science honor societies or clubs, writing of essays for the American Chemical Society prize essay contest and a more generous use of the library are submitted. Permission to participate in these privileges is conditioned upon better than average success in the regular work of the course. B. C. H.

The Project Method; Some Advantages and Disadvantages. R. C. PERRY. *High Sch. Teacher*, **6**, 59–60 (Feb., 1930).—Some of the 118 positive and negative qualities enumerated which may be of interest to teachers of chemistry include:

(1) the motor minded child benefits; (2) the child discovers what he can do; (3) observation is developed; (4) originality is encouraged; (5) ability to generalize is developed; (6) it teaches the assembly of data and facts; (7) material is discovered rather than taught; (8) the school becomes a laboratory rather than a lecture hall.

Some adverse characterizations are: (1) the project may become merely an object for display; (2) it is difficult to find and sometimes more difficult to procure materials; (3) excursions are hard to arrange with other teachers, parents, etc.

In general the advantages seem to lie mainly with the pupil and the disadvantages are to the curriculum and the administration. Again it may be said, "No one method will solve our educational problem." B. C. H.

Suggestions for Study Supervision. O. W. KOLBERG. *High Sch. Teacher*, **6**, 79–80 (Feb., 1930).—From data from forty-four high schools of the North Central Association of Secondary Schools the author reports that 60% of them do not make any provision for study supervision by the teacher, that only 16% of the pupil's time is supervised, "the rest of it is left for him to use or waste as he sees fit" and that 84% of the schools emphasize quiet in preference to supervising study.

The usual practice is to have one teacher in charge of the study room, a different teacher for each successive period. This supervisor spends most of his time acting as a monitor with a chief interest in keeping order. It is more common to have all students studying in a large study hall with about 150 other students present than to have such study occur in the classroom under the class teacher.

His judgment is: "If we correctly evaluate the study time of pupils, we will provide just as carefully for its supervision as we do for the classroom. Study supervisors should be hired for their special aptitude in this line of work." B. C. H.

A Science Department and Motion Pictures. W. A. REDENBAUGH. *Educ. Screen*, **9**, 6–7 (Jan., 1930).—An interesting story is told under the above title of how a well-organized science club not only "put science on the map" of that high school but purchased and paid for two projectors, one a 16-mm. machine and the other a 35-mm. machine.

The club has one general meeting per month with what might be called a science feature film shown each time. Such general programs are always followed up by a class discussion.

In addition to these main programs a large number of films, mostly 16 mm., are shown in the classrooms. A list of some of the films which have been found satisfactory for such use is presented and the method of their use in connection with the regular school work is described. B. C. H.

ADMINISTRATIVE PROBLEMS AND DEVICES; CURRICULA

A New Plan of Registration. C. E. SEASHORE. *J. Higher Educ.*, **1**, 36–7 (Jan., 1930).—Describes briefly the plan of individual study for doctorate candidates at the State University of Iowa. H. H. K.

A New Executive Committee. E. H. WILKINS. *J. Higher Educ.*, **1**, 37–8 (Jan., 1930).—At Oberlin College a faculty committee has been created to exercise the powers of the board of trustees in the interval between trustees' meetings, and to represent the faculty at these meetings. H. H. K.

Self-Education in Harvard College. A. L. LOWELL. *J. Higher Educ.*, **1**, 65–72 (Feb., 1930).—A discussion of the Harvard scheme of self-education which combines the honor course, tutorial instruction, and reading periods. H. H. K.

KEEPING UP WITH CHEMISTRY

Practical Atomic Weights 1930. *Chem.-Ztg.*, **54**, 52 (Jan. 15, 1930).—The German Atomic Weight Committee consists of M. Bodenstein, O. Hahn, O. Hönigschmidt (*chairman*), and R. J. Meyer. The committee recently published its tenth report in which it was stated that the articles published from December, 1928, to November, 1929, did not justify any great change of the preceding table of Atomic Weights (*Chem.-Ztg.*, **53**, 1929, p. 52). However, the element Rhenium, Re = 188.7, was added and the atomic weight of oxygen was given as 16.0000 on account of the atomic weight of hydrogen. L. S.

Calorimetry, Its Importance and Practice in the Gas Industry. W. E. STACKHOUSE. *Instruments*, **3**, 77–81 (Feb., 1930).—A discussion of the fundamentals of calorimetery. H. H. K.

Chemistry in Incandescent Lamp Manufacture. W. J. BARTLETT. *Ind. Eng. Chem.*, **21**, 970–2 (Oct., 1929).—In connection with the fiftieth anniversary of the discovery of the electric light by Edison, celebrated by the "Light's Golden Jubilee,"

this article from the Incandescent Lamp department of the General Electric Company on "Chemistry in Incandescent Lamp Manufacture" is of considerable interest. There are a number of interesting illustrations showing Edison at work in his laboratory, a fine photograph of Edison, and another of his restored laboratory, and an especially interesting chart of the pictorial history of artificial light. The subject matter deals briefly with problems in the industry where chemistry is of great importance and is presented under the headings (1) tungsten, (2) gases used for filling the bulbs, (3) getters for cleaning up residual gases in the bulb, (4) basing cements for cementing the glass part of the bulbs to the metal bases, (5) inside frosting, (6) coating for colored lamp.

BYCK

Chemical Warfare Service Saves Millions for Industry. R. S. SADTLER. *Chem. Met. Eng.*, **37**, 88–90 (Feb., 1930); cf. THIS JOURNAL, **5**, 1505–9 (Nov., 1928).—The Chemical Warfare Service has proved itself of value to America in peace time by important contributions to chemical science and industry of the nation as a whole. Among the more important of these is the development of compounds that will destroy the boll weevil more effectively than the calcium arsenate generally used. The service has demonstrated itself in the use of tear gas in controlling mobs; it has developed masks for protection against industrial fumes, and an efficient method for fumigating buildings. There have also been developed toxic ship bottom paints, protection for marine piling, and a better and safer method of fumigation of ships, all of which have proved valuable to the shipping industry. R. L. H.

Fire-Proofing. ANON. *Silicate P's & Q's.*, **10** (Feb., 1930).—A silicate spray, or paint, has been found useful in reducing the fire hazard in bridge and mine timbers, and certain cloth fabrics. Danger of fires resulting from matches and cigarettes may be reduced by use of silicates. Many housewives may aid the family exchequer by purchase of a supply of eggs during the season when they are cheap, and preserving them with silicate. H. T. B.

Fuels and Combustion. W. J. WOHLENBERG. *J. Eng. Educ.*, **20**, 405–21 (Dec., 1929).—In 1926 the world at large was obtaining seventy-five per cent of its utilized energy from coal, sixteen per cent from oil and gas and less than nine per cent from water power.

In addition to its energy product coal should be looked upon as a storehouse of valuable materials. To utilize these depends upon the type of processing which coal is subjected to. Four such types of treatment are listed as: high-temperature carbonization, complete gasification as into producer and blue water gas, low-temperature carbonization and hydrogenation.

The first of these is carried on largely to meet the demand for metallurgical coke. By-products from this method are tar, gases, and ammonium sulfate. Low-temperature carbonization is used that less "cracking" may result. This process yields a more volatile coke, a gas of higher heat value but a lower output of ammonium sulfate.

Coal hydrogenation was developed by Doctor Bergius in Germany. Oil is the chief product of the treatment. The treatment is accomplished in two steps: in the first the coal is heated in an atmosphere of hydrogen, at from 300 to 350°C. This produces a pitch-like product which is subjected to the same hydrogen atmosphere but at the higher temperature of 450°C. This second reaction is virtually a "splitting" process which produces shorter-chain hydrocarbons.

The combustion engineer has the problem of designing a furnace which will secure a near approach to a 100 per cent release of the energy which the fuel can yield upon complete combustion. The factors involved in this aspect of combustion are: quantity of combustible space, free oxygen space, quantity of inert gases that have to be provided for, the diffusion and turbulence factor and the temperature of the mixture. Thus a process which, viewed superficially, seems to be rather simple, is in fact a succession of very complex transformations and involves not only the chemical transformation but many more factors which are less well understood. B. C. H.

The World's Sugar Industry. ANON. *Chem. Age*, **22**, 23–4 (Jan. 11, 1930).—A reproduction of parts of a Streatfield Memorial Lecture delivered recently by Lewis Eynon. The article contains a brief history of the development of the cane sugar and beet sugar industries from early times to the present time. Sugar may be used in the future as a source of alcohol to be used as fuel. Four tons of sugar, a moderate yield for one acre of sugar cane, will yield 520 gallons of alcohol, enough to support two small cars for a year, each car traveling 7000 to 8000 miles. E. R. W.

Organic Chemicals as Rubber Accelerators. *Syn. Org. Chem.*, **3**, No. 3 (Feb., 1930).—A brief classification and discussion of the organic compounds useful for this purpose. H. H. K.

Hot Plastic Shipbottom Paints. B. L. WEHMHOFF, A. M. JORDON, AND H. C. KNIGHT. *Chem. Warfare*, **15,** 675–80 (Dec. 15, 1929).—Preliminary reports indicate that paints made up of rosin and various soaps of lead, mercury, and arsenic, with small amounts of turpentine or pine oil, when applied to ship bottoms in a hot, plastic condition will harden and protect the bottoms against the attachment of various marine organisms. These paints are more expensive than ordinary varnish paints but they will prevent fouling and corrosion for a greater length of time. This work has been carried out at Edgewood Arsenal. E. R. W.

Extraction of Helium from Monazite Sand. R. TAYLOR. *Chem. and Ind.*, **48,** 369T–372T (Dec. 27, 1929).—Monazite sand from Travancore, India, contains about 1 cc. of helium per g. of sand, the gas may be driven out by heating. Carbon dioxide is removed by washing with concentrated sodium hydroxide solution, and the nitrogen is removed by passing the gas over magnesium heated to about 600 degrees. Plant equipment for carrying this out on a commercial scale is described. E. R. W.

Copper Alloys Containing Silicon. ANON. *Chem. Age, Mo. Met. Sect.*, **22,** 1–2 (Jan. 4, 1930).—Silicon has been used in small amounts in copper alloys as a deoxidizer and as a hardener. When present to the extent of about 5%, silicon greatly increases the tensile strength of copper wire and cuts down its ductility, the electrical conductivity is lowered also. Special alloys containing copper, silicon, and manganese give castings which are easily worked and which are quite resistant to acid corrosion. E. R. W.

Producing Alumina by Acid and Electrothermal Processes. J. D. EDWARDS AND R. B. MASON. *Chem. and Met. Eng.*, **36,** 730–3 (Dec., 1929).—Search has been made for a commercial process of extraction of alumina from clay since clay may be found anywhere and at almost no cost. Clay, however, contains only 30% to 40% alumina as compared to 60% alumina in bauxite. The acid extraction process is recommended for those ores low in iron, for this eliminates the silicates which are invariably present. On the other hand the alkali extraction eliminates the iron which may be present. The ores are usually digested in 60% sulfuric acid, the aluminum sulfate collected and repurified. The alumina used for electrolytic reduction should not contain more than 0.05% Fe_2O_3. The aluminum sulfate is collected in the solid form after purification, and decomposed into pure alumina by calcination for electrolytic reduction. The electrothermal process depends upon the reduction of the impurities to the metallic state, and then separating them from the pure alumina. R. L. H.

Aluminum Chloride's Debut. *Ind. Bull. A. D. Little, Inc.*, No. **36** (Dec., 1929).—Although the preparation of aluminum chloride was known as early as 1868, and numerous organic reactions in which aluminum chloride plays the important rôle were discovered in 1877 by Friedel and Crafts, only recently through the efforts of the Gulf Refining Company and McAfee, has it become one of the important industrial heavy chemicals. Its use in organic synthesis was early limited to preparation of costly substances since it was itself expensive. During the war it was used in preparation of toxic and tear gases. McAfee extended the reactions in which it was used to include the petroleum hydrocarbon and developed the process, named after him, for converting high-boiling petroleums into gasoline, using aluminum chloride. The cost when the process was first developed, was $1.50 per pound and only after overcoming tremendous engineering difficulties was it possible to manufacture it at a cost of only 5¢ per pound. This reduction in price has made it possible to apply the Friedel-Crafts reaction in cases previously of insufficient importance to warrant the prohibitive cost, but which now become economically feasible. Dye bases, artificial perfumes, and certain drugs are prepared by synthesis involving the use of aluminum chloride.

The property of aluminum chloride which is the basis for all of these syntheses is its ability to form unstable reactive compounds with the hydrocarbons—these addition products are able to react in many ways impossible with the original hydrocarbon. BYCK

Weather Proof Iron. *Ind. Bull. A. D. Little, Inc.*, No. **36** (Dec., 1929).—A recent outstanding development in ferrous alloys is a class known as chrome-nickel iron, of special interest in this day of demand for non-corrosive metals. A typical analysis shows 18% chromium, 8% nickel and up to 0.20% carbon and should not be confused with the alloys of quite different composition known popularly as "stainless steel."

Chrome-nickel iron is sold under many trade names such as Allegheny Metal, Carpenter Stainless Steel No. 4, Defistain Rustless Iron, Duraloy 18–8, Enduro KA2, Midvale V2A, Resistal KA2, Stainless N, Sterling Nirosta and Sweetaloy 17. It melts at 2500 to 2700°F., takes a beautiful mirror polish untarnished by atmospheric conditions and is extremely resistant to a large variety of chemicals, gases, and organic acids. This

latter property makes it useful in the canning industry or wherever fruits and vegetables or their products are to be handled.

Another valuable property is the ability to retain its tensile strength at high temperatures which makes it useful for high-pressure high-temperature work such as cracking gasoline. The metal is readily welded and can be worked with no unusual difficulty. Methods of heat treatment covered by Krupp patents are believed to make the metal more easily worked. Its uses are manifold, and most recent interesting uses are in the new Chrysler building in New York where the entire tower is to be covered with this metal. It will replace many articles which are now nickel plated and where a solid metal has advantages over plated articles. BYCK

Progress of Organic Chemistry, 1924–1928. II. E. LEHMANN. *Z. angew. Chem.*, **43**, 6–12 (Jan. 4, 1930); 47–8 (Jan. 11, 1930); 63–6 (Jan. 18 1930); cf. THIS JOURNAL, **6**, 2050, 2282 (1929).—*Aliphatic Series:* 1. *Hydrocarbons. a.* Saturated. *b.* Unsaturated. *c.* General considerations. *d.* Simple unsaturated. *e.* Complex unsaturated. *f.* Rubber. 2. *Oxy-compounds. a.* Monoxy. *b.* Dioxy. *c.* Trioxy. *d.* Tetra- and polyoxy. *e.* Oxides. *f.* Ether. 3. *Oxo compounds. a.* Aldehydes. *b.* Ketones. *c.* Ketenes. *d.* Oximes. 4. *Oxyoxo compounds (sugar group).* Monosaccharides, Disaccharides. L. S.

The Mutual Influence of Organic Compounds in the Animal Body. F. KNOOP. *Science*, **71**, 23–5 (Jan. 10, 1930).—One organic compound undergoing oxidation gives H_2 to a reducible substance such as an aldehyde or a ketone, and transfers with it some of its heat of combustion. This extra energy explains why the process may take place spontaneously and can well be accelerated by catalysts.

Most oxy- and ketonic acids are interconvertible. Probably every organic substance in the body has in relation to every other one a certain redoxpotential which will vary according to the condition of pH, of temperature, of O_2 concentration, of the catalysts present, etc. G. H. W.

Significant Developments Regarding Soil Corrosion. H. W. HOUGH. *Sci. Mo.*, **30**, 132–40 (Feb., 1930).—An illustrated article dealing with some of the problems involved in the study and correction of corrosion of various metals buried in different locations. It has been found that the rate of corrosiveness is proportionate to the rate at which hydrogen is evolved and removed from the surface of the metal. This serves as a means of measuring corrosion. In addition to this, practical methods for appraising and charting the relative intensity of soil corrosion in various locations have been worked out. These involve both a chemical study of the soil and a topographical survey of the localities. The chemical analysis involves a determination of the relative proportion of soluble salts, the amount of moisture, the active acidity of pH, and the total acidity. From these and other accelerating or inhibiting factors, the soils are given a relative corrosion rating. G. W. S.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

Recent Progress in the Chemical Study of the Vitamins. J. C. DRUMMOND. *Chem. & Ind.*, **49**, 1T–10T (Jan. 3, 1930).—*Messel Memorial Contribution.* We are still in doubt as to whether vitamin A is a single chemical individual or a group of substances. This vitamin may be concentrated in the non-saponifiable fraction of solutions of it in oil. Attempts to identify it as carotene or dehydroergosterol have so far been unconvincing. Evidence seems to indicate that vitamin D is formed from ergosterol by a photochemical reaction. Vitamin E may be concentrated in the non-saponifiable fraction of wheat-germ oil but as yet nothing to indicate the chemical nature of the active substance has been published. Vitamin C may be concentrated from lemon juice; some of the conditions which determine the stability of this vitamin have been studied but very little is known as to its chemical nature. Vitamin B is probably a mixture of three vitamins. The B_1 variety appears to be a basic substance of relatively simple composition, and we may expect that in the near future its nature and constitution will be established. Very little is known about the other two vitamins B_2 and B_3.

"It is truly remarkable that so fundamental a process in the life of the animal as the formation of its bony skeleton should be dependent on the supply from external sources of an infinitesimal amount of a substance closely related to one which the tissues can synthesize." (Vitamin D and ergosterol.) E. R. W.

The Uses of Sodium Thiosulfate in Analytical Chemistry. E. DONATH. *Chem.-Ztg.*, **54**, 78–9 (Jan. 25, 1930).—The author gives a brief and critical review of the many important uses of sodium thiosulfate in analytical chemistry. They are: 1. Decomposition of ores containing arsenic and antimony. 2. The precipitation of sulfides by means of sodium thiosulfate, based upon work of Georg Vortmann. Sodium thiosulfate

can be used for the quantitative separation of copper from cadmium or zinc. 3. Separation of iron from aluminium. A neutral mixture of ferric chloride and aluminium chloride is boiled with excess sodium thiosulfate whereby the iron is reduced to ferrous chloride while aluminium hydroxide precipitates.

$$2\ Na_2S_2O_3 + 2\ FeCl_3 = 2NaCl + Na_2S_4O_6 + 2\ FeCl_2$$
$$2\ AlCl_3 + 3\ H_2O + 3\ Na_2S_2O_3 = 6\ NaCl + 3\ SO_2 + 3\ S + 2\ Al(OH)_3$$

4. Chancel's method of separating iron oxide from alumina. 5. The titration against iodine. L. S.

That Peculiar Thing, Temperature. M. F. BÉHAR. *Instruments*, **3**, 2, 129–35 (Feb., 1930).—A discussion of temperature and temperature scales; gives the International Temperature scale published in THIS JOURNAL, **6**, 1352–4 (July-Aug., 1929). H. H. K.

HISTORICAL AND BIOGRAPHICAL

Robert Andrews Millikan. (1) *Les Prix Nobel en 1923.* P. A. Norstedt & Soner, Stockholm, Sweden, **1924,** pp. 20–3, 79–81.—Contains a brief outline of work for which the Nobel award was made, brief biographical notes, summary of researches, and portrait. (2) *Elec. World*, **78,** 502 (1921).—Biographical notes. (3) *Ibid.*, **80,** 1347 (1922).—Account of award of Edison Medal to Millikan. (4) *Science*, **59,** 325–6 (1924).—Account of presentation of Nobel prize. (5) *Ind. Eng. Chem.*, **16,** 131 (Feb., 1924).—Millikan awarded Hughes Medal by Royal Society of London in recognition of his work on the determination of physical constants. (6) *Ibid.*, **15,** 1287 (Dec., 1923).—Short note on Nobel prize award. (7) *Forum*, **82,** 193–201 (Oct., 1929). "What I Believe," by R. A. ANDREWS. Millikan's philosophy of life. M. W. G.

The William Hoskins I Know. L. V. REDMAN. *Chem. Bull.*, **17,** 42–4 (Feb., 1930).—Hoskins has devoted himself to science in an untiring manner. His contacts are many and varied. "William Hoskins, who has long been acclaimed dean of western consulting chemists, has not confined himself to giving scientific counsel only. Through most of these 50 years he has been a fountain of hope to the discouraged, an inspiration to the ambitious, a companion of the strong, and always an unselfish, devoted, big brother to us all." H. T. B.

Chemistry Then and Now. W. HOSKINS. *Chem. Bull.*, **17,** 40 (Feb., 1930).—"Then"..in 1880, there were three chemists in Chicago trying to make a living. Manufacturing processes were based on hit and miss, rule of thumb methods. Much of the chemical work was confined to testing and analyzing ores, checking imported materials, and settling disputes. Apparatus was largely imported, and expensive. Instructors in chemistry had little practical experience; college laboratories were below the standard of present-day high-school laboratories. "The center of the movement of chemical application to industry is now in research, the modern question mark." H. T. B.

William H. Nichols. See page 1112 of THIS JOURNAL.

Jöns Jakob Berzelius. R. WINDERLICH. *Z. physik. chem. Unterricht*, **42,** 193–203 (Sept.-Oct., 1929).—Jöns Jakob Berzelius was born at Väfversunda in Ostgotland on August 20, 1779. His parents died when he was a few years old. At the age of 14 he entered the Gymnasium at Linköping; he worked his way through school by tutoring. His love of natural science was not greatly appreciated by his teachers and his diploma stated that he was a good-natured young man with bad manners and doubtful chances for the future. When a student at the University of Uppsala he surprised the faculty and his fellow students by his discovery of a method of preparing oxygen. During the vacations he worked in a pharmacy at Vadstena where he learned the art of blowing glass. Later, as a physician in Stockholm, he became acquainted with W. v. Hisinger who was the owner of a mine. They began some research work in order to discover the laws which govern the chemical action of galvanic columns. The results of their work appeared in 1803 and formed the basis of the electrochemical theory which was developed later. Five years afterward he became lecturer in chemistry at Stockholm. In 1807 he was elected professor, and in 1809 a member of the Academy. His "Tierchemie" appeared in 1806 and the first volume of his famous "Textbook of Chemistry" was published in 1808.

Berzelius had to prepare all his chemicals as they could not be bought in Sweden. He invented the alcohol lamp and the wash bottle; he substituted rubber tubing for leather tubing; he showed that it was more accurate to work with sensitive balances and small quantities of materials and he taught a large number of simple devices which facilitate chemical work. From the analysis of many compounds he came to believe that there existed definite and simple proportions between the quantities of elements that are present in any compound. At first he doubted the correctness of Dalton's Theory

but he soon became its most ardent defender. However, he soon found that Dalton's figures were not very accurate. This was the cause for his tremendous amount of work on the atomic weights of elements. His first table of atomic weights appeared in 1814; an enlarged and corrected table of 1818 listed 46 elements and 2000 compounds which he had analyzed himself. Berzelius referred all his atomic weights to oxygen which he regarded as the "Pole of Chemistry." He advised his students that a given sample should always be analyzed in various ways and that one should always obtain at least three checks and should never be satisfied with just one analysis.

His article "Über die chemische Zeichensprache und die Art ihrer Anwendung zum Ausdrucke der chemischen Proportionen" [Schweigger's, *J. Chem. Phar.*, **13**, 240–3 (1815)] marks him as the creator of chemical symbols and their applications. He showed how to calculate per cent composition from the formulas derived. Berzelius developed quite an interesting mechanism for chemical reactions on the assumptions that every chemical process was also an electrical process. He systematized chemical knowledge and classified all substances into electronegative (acids), electropositive (bases), and indifferent.

In the winter 1812–13 he was given a large collection of minerals. In order to be able to arrange the ores systematically he began an intensive study of mineralogy. He soon found that the classifications then used were not very efficient and began to work out a scientific system of mineralogy by the application of the electrochemical theory and chemical proportions. He stated in various articles published at that time that mineralogy should be a subdivision of chemistry. He proved that any given mineral had always the same composition no matter where it came from. After various attempts he finally worked out a classification in which the minerals are arranged according to their electronegative compounds.

During the analysis of the slimy mud at the bottom of a sulfuric acid plant he discovered the element selenium. He emphasized the fact that sulfur, selenium, and tellurium formed a triad just as chlorine, bromine, and iodine. Later he announced the discovery of thorium and the preparation of elementary silicon, titanium, tantalum, and zirconium. He did a large amount of work on molybdenum, vanadium, the noble metals, thiosalts, Cassius' Goldpurple, tartaric acid, and others. He coined the terms isomerism, polymerism, allotropy, and catalysis when illustrating and explaining the results of his works.

From 1821 until his death on August 7, 1848, he published his "Jahresberichte" in which the great master gave very complete yearly reports on chemistry and related fields. L. S.

The Liebig Museum in Giessen. F. HILDEBRANDT. *Chem.-Ztg.*, **53**, 889 (Nov. 16, 1929).—In the winter of 1910–11 a number of men of science and industry met to found the "Gesellschaft Liebig Museum." They planned: (1) to purchase the Liebig laboratory and to renovate it; (2) to erect a Liebig museum in the same building; (3) to further the cause of chemistry. The building was bought. Many of the various pieces of apparatus which Liebig had used and which had been taken to other places were brought back. The rooms were put in their former condition. Books and many other objects were obtained that dealt with Liebig and his laboratory. The author suggests the following program for the Society: 1. to arrange the apparatus and utensils in various groups such as to show the primitive character of a chemical laboratory of 100 years ago and to publish a guide for the laboratory together with a biography of Liebig; 2. to build up the library which should consist mainly of the original articles of Liebig; 3. to publish the letters of Liebig and his friends.

The author closes his article with an appeal to the men of science and industry to aid financially and to enlist new members. L. S.

Calorimetry in America. S. W. PARR. *Instruments*, **3**, 71–6 (Feb., 1930).—A historical discussion of the development of calorimetry in America. H. H. K.

The Centigrade Thermometer. G. F. HENNION. *Catalyzer*, **7**, 1–3 (Oct., 1929).—It is well known to every student of chemistry and physics that the centigrade (or Celsius) laboratory thermometer was named after the Swedish astronomer, Anders Celsius, who first proposed such a measurement of heat in a paper in 1742 before the Swedish Academy of Sciences "on the measurement of heat."

Five years before this paper, in 1737, Carolus Linnaeus, a botanist (who was later to occupy the chair of botany at Celsius University) published a one-volume book, "Hortus Cliffortianus," describing the botanical specimens in the gardens of George Cliffort, a banker. In this volume, by peculiar circumstance, there is reference to what is undoubtedly the centigrade thermometer. It appears in Linnaeus' book in the following way.

The frontispiece of the original is an artistic study. In the center foreground are

shown, among other objects, six people in various poses, several potted plants, a tree and a dragon. In the near foreground there appears a small child seated on a step, and a second child standing, who leans on a garden spade. The seated child holds in his right hand a mounted thermometer at which he is pointing with the forefinger of his left hand. The startling fact is that the thermometer is a centigrade one without a doubt. The graduations are clear. There are exactly 100 above zero, and 100 below. The number 1 is in the center of the scale, while graduations are marked by tens in Arabic numerals. This is then essentially the centigrade thermometer disclosed five years before the paper by Celsius. No reference to indicate the location of freezing or boiling points can be found in Linnaeus' writings. The article contains a full-page reproduction of a part of the original frontispiece. BYCK

History of the Bunsen Burner. *Z. Komprimierte Flüssige Gase*, **28**, 48 (1929).—In reply to a communication from Feldhaus (*Chem. Apparatur*, **14**, 252) according to which the gas engineer R. W. Elsner independently and contemporaneously with Bunsen invented the non-luminous gas burner, Prof. Biltz shows (*Z. angew. Chem.*, **41**, 112; see THIS JOURNAL, **6**, 391 (Feb., 1929) for abstract of this article) that the principle had even been used by Faraday. In the 1828 edition at Weimar of Faraday's book "Chemical Manipulation or the Necessary Technic of Successful Chemical Experiments" a detailed description is given on pp. 128–30 of such gas burners. This burner had a brass or copper cone fastened on to the burner tube. This cone was similar to the present-day Bunsen chimneys, but the upper opening was much smaller, and indeed only slightly larger than the opening of the burner tube. By pushing the cone down, a luminous flame was obtained. Similar arrangements were also described for Argand burners and other ring-shaped burners. A model of Faraday's burner has been put on exhibition in the Deutsches Museum. Even though the principle of the burner was not original with Bunsen, the modern form of it is nevertheless due to the monograph used in the Heidelberg laboratory entitled "Wire Gauze Burners and Other Arrangements for Maintaining Steady Flames with Varying Light Intensity." The original Bunsen burner had four openings below in a square piece of metal, through which the primary air was admitted. These had to be stoppered individually when a luminous flame was desired. The movable collar was a later addition. H. C. DUUS

EDUCATIONAL MEASUREMENTS AND DATA

The Student's Working Load. F. W. REEVES AND J. D. RUSSELL. *J. Higher Educ.*, **1**, 85–90 (Feb., 1930).—By means of interviews and questionnaires the authors determined the working load of college students and found it to be much less than the accepted theoretical standard of three hours of work for each hour of credit. H. H. K.

Student Honesty in a University with an Honor System. W. G. CAMPBELL AND H. L. KOCH. *Sch. & Soc.*, **31**, 232–40 (Feb. 15, 1930).—An extensive study of student honesty at a large state university where an honor system had prevailed for many years, revealed that all degrees of dishonesty existed. The thoroughness of supervision and the seating of an individual during examinations were, of course, influential factors as to the extent of cheating. Lectures on honesty apparently had little or no effect and indications were that there was much less cheating among students who had been supervised during their secondary training than among those trained under an honor system. K. S. H.

The Reliability and Validity of Oral Examinations. E. J. BARNES AND S. L. PRESSEY. *Sch. & Soc.*, **30**, 719–22 (Nov. 23, 1929).—Results obtained in examining graduate students by committees composed of other such students, in an attempt to ascertain the reliability and validity of oral examinations, are given. Because of the information obtained, the writers stress the importance of a scientific experimental attack upon problems of higher education. K. S. H.

THE PHILOSOPHY OF EDUCATION

Need of a New Type University. D. E. PHILLIPS. *Sch. & Soc.*, **30**, 627–32 (Nov. 9, 1929).—In setting forth some of the glaring faults of our present system of college education, the author shows how students come to college for countless other reasons than the pursuit of knowledge and how faculties are chosen and promoted for all manner of reasons other than an ability to teach.

An entirely new type of educational institution is proposed, where students may come at sixteen without entrance requirements, and where only those who come for the real joy of study will be interested in staying. Such an institution will be without secret

societies, athletics, extra-curricular activities, and will grant no degrees. Persons entering will gain a broad cultural background and will stay as long as they wish. They will leave when they are satisfied that they have exhausted the resources of the institution in the subjects in which they are interested. K. S. H.

Academic Freedom in a Christian College. E. D. SOPER. *Sch. & Soc.*, **30**, 521–33 (Oct. 19, 1929).—Dr. Soper discusses the problem of free-speech in a university and maintains that no student, because of the influence of some faculty member, should be robbed of the religious experience he possesses or turned away from what might otherwise be a Christian life. It is the right and duty of every Christian college to control its teaching to some extent—to strike, if possible, a happy medium whereby justice may be done to both academic freedom and the maintenance of Christian character. If an instructor is definitely constructive, he will be able to present to students the present-day interpretations of religious and other problems so that they will be acceptable; laying for them even a better foundation than they previously possessed. They will not be left hopelessly suspended in mid-air. K. S. H.

Building Character in Our Secondary Schools. G. W. ROSENLOF. *Neb. Educ. J.*, **10**, 69–70 (Feb., 1930).—Some constructive suggestions looking toward character building find expression in: formulation of a school code by the pupils themselves; responsibility shared by the pupils in the administration of such a code through some form of student self government; a wise use of convocation periods to establish *esprit d'corps* of the student body as a whole; encouragment of pupil activity in school clubs. Motto, "Every student active in some school organization;" a fuller recognition and use of the school library as a very important tool for character building; a conscious effort put forth in making both pupils and teachers appreciative of the school plant—grounds, buildings, equipment, and adornment.

A program of physical education and athletics affords a most salient opportunity for either building or tearing down character. "Every subject in the curriculum affords ample opportunity for inculcating ideals, attitudes, perspectives. Moral qualities of every sort are inherently a part of every subject." B. C. H.

Self-Education in Harvard College. See this title on page 1194.

The Spirit of the University of Chicago. Presidential Address. R. M. HUTCHINS. *J. Higher Educ.*, **1**, 5–12 (Jan., 1930).—A characterization of the university's past and an outline of its future. Presents the idea that constant research and experimentation are the functions of a university. H. H. K.

PROFESSIONAL

Teachers Wanted. J. G. BOWMAN. *J. Higher Educ.*, **1**, 13–6 (Jan., 1930).—The author describes the good teacher as one who can vitalize facts; one who teaches students to be more than mere technicians; one who implants in them some one steady ideal. H. H. K.

The Plain Facts about the Status of College Teaching. H. T. MCKINNEY. *Sch. & Soc.*, **31**, 119–21 (Jan. 25, 1930).—Dr. McKinney attacks the statement recently made that "the best teaching in America is in the primary grades, the next probably in the high schools and the poorest of all in the colleges." No generalization can be made that college teaching is poorer in all respects than that of primary and secondary schools. The high-school teachers have their complaints concerning the material passed on to them from the lower grades, and the colleges wonder how many of the pupils ever "got by" their elementary and high-school courses. It being the duty of the college to turn out in four years, a finished scholar, the necessity of thorough early training is obvious. Good, bad, and indifferent teachers are to be found everywhere and are not typical of any one phase of education. K. S. H.

Some Examples of Student Criticism of Teaching. G. S. WYKOFF. *Sch. & Soc.*, **30**, 512–3 (Oct. 12, 1929).—This article cites some of the constructive and destructive criticisms of teaching as made by students at Purdue University. These criticisms are obviously very deeply colored by the temperament and interest of the individual. K. S. H.

The Teacher Again. G. NORLIN. *Sch. & Soc.*, **30**, 351–6 (Sept. 14, 1929).—The ideas held by university professors regarding the nature and worth of teaching in secondary schools, and vice versa, is set forth by Dr. Norlin who is inclined to agree with school superintendents that failures in college are due to the fact that the individuals have passed from the hands of competent teachers into those of untrained instructors.

Existing impressions of present-day education, and of those engaged to impart knowledge, are cited, and recommendations to graduate schools—as resolved upon at the Chattanooga Convention—are given. K. S. H.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

The Spirit of the University of Chicago. *Presidential Address.* R. M. HUTCHINS. See this title on page 1201.

The American Association for the Advancement of Science; Reports of the Des Moines Meeting. *Science*, **71**, 137–68 (Feb. 7, 1930). G. H. W.

Priestley Medal Award. *Ind. Eng. Chem.*, **21**, 896–8 (Oct., 1929).—A report of the meeting on September 11, 1929, at Minneapolis for the purpose of presenting to Mr. Francis P. Garvan the Priestley Medal. This report contains a brief history of the founding of the Priestley Medal for distinguished services to chemistry and a brief summary of Mr. Garvan's contributions to chemistry by Irving Langmuir, president of the American Chemical Society; a short address of acceptance by Mr. W. W. Buffum for Mr. Garvan who was not present because of poor health; a short address by Julius Stieglitz, who then read Mr. Garvan's address "Random Thoughts of a Lay Chemist." The three "random" thoughts which Mr. Garvan considers concern the relation of the development of American chemistry to the furtherance of the peace of the world; chemistry as an agent of peace; and considerations of the causes for a lack of proper appreciation and assistance for the development of American chemistry.

Mr. Garvan is the third recipient of the Priestley Medal—the others were Ira Remsen (1923) and Edgar F. Smith (1926). BYCK

The Perkin Medal Award Address. See **"Economic Trend in the Chemical Industry,"** by H. H. Dow, page 1202 of this issue.

GENERAL

Industrial Progress Made through Research and Its Economic Importance. W. R. WHITNEY. *Metals & Alloys*, **1**, 370–2 (Feb., 1930).—The growth of the creative spirit has reached a point where men enjoy working because of the artistic and creative urge. The history of research has been about the same in all countries as its earliest impulses came from the monks. Perhaps in no one case is the effect of long-continued academic research more in evidence than in the chemical industry, upon which enormous and varied industries were established. Industrial research is something designed to discover unused materials and processes, to bring about better use of old materials, to reveal new wants, create new desires, and actually predetermine new needs. R. L. H.

Economic Trend in the Chemical Industry. H. H. DOW. *Chem. & Ind.*, **49**, 38T–40T (Jan. 17, 1930).—Abridged paper from the address delivered on the occasion of the presentation of the Perkin Medal to the author. The four most conspicuous labor-saving devices in chemical plants are: (1) larger equipment; (2) automatic analysis; (3) automatic operation; (4) continuous operation. As concrete examples the development of bromine recovery and the manufacture of magnesium sulfate, are outlined briefly. E. R. W.

German Gas Contains Helium—but Not Enough to Be Useful. There are natural gas wells in Germany whose output contains helium, writes Kurt Weil in *Die Umschau*, a well-known German scientific periodical. But there is no prospect of the Graf Zeppelin or any of her future sister airships being filled with German helium, for the combined product of all of the four German wells whose gas contains this valuable element would have to be accumulated for 400 years before there would be enough to fill the Graf.

By means of extremely delicate tests devised by Profs. Paneth and Peters, noted German analytical chemists, the percentage of helium was determined for a number of gas wells in Germany. The richest of these was a small well at Ahlen, Westphalia, whose product assayed nineteen hundredths of one per cent helium. But this well flows only 41 cubic meters of gas a day, and would therefore yield the relatively insignificant volume of eight-tenths of a cubic meter of helium in that period. As compared with this, Herr Weil cites the great American well at Petrolia, Texas, which yields 425,000 cubic meters of gas, with a helium content of nine-tenths of one per cent. This would fill a Graf Zeppelin in a few days. The German writer adds the comment that Nature has treated Germany, the home of the Zeppelin, "like a stepmother."—*Science Service*

Local Activities

Purpose and Organization

The purpose of the Local Activities Section of the JOURNAL OF CHEMICAL EDUCATION is briefly but clearly stated in its title. Any items of local news from institutions, A. C. S. Sections, Teachers' Associations, or other organizations which are of such a nature as to make them of more than purely local interest rightfully belong to this Section.

The responsibility of reporting items for this section rests entirely with the local institutions and organizations. It is desirable to have a representative appointed to report news regularly. Suitable material sent to the editorial office before the 20th of each month will be published in the following month's journal. The Editorial Staff must necessarily reserve the right to abridge or totally reject any items submitted. If the following suggestions are followed, however, the necessity for such action will be largely obviated.

Material to Be Reported

1. Notices of local scholarships or fellowships and announcements of new or unusual courses in chemical education or special fields of chemistry.
2. Reports of dedication of new science buildings, stressing the unique features.
3. News notes concerning activities of prominent scientists and educators and of the honors and awards made to them.
4. Promotions within, or changes of, personnel of a department.
5. Notices of any special gifts to chemical organizations or departments—as fellowships, endowments, laboratory gifts, library gifts, etc.
6. Accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which might be suggestive to other organizations. Where original or unusual features are included, it is desirable that they be described in some detail.
7. Any subscriber to the JOURNAL, desiring new teaching position or seeking eligible candidate for teaching vacancy, is entitled to two free announcements yearly in this column.

Situation Wanted: Young man of 26 desires teaching position in small college or large city high school in Middle West. Holds B.S., M.S. in chemistry. Two and one-half years successful teaching experience. Reason for desiring change is to secure better position. Married. Good health. Address: HOMER R. DUFFEY, Washington Park High School, Racine, Wisconsin.

Situation Wanted: Young man of 27 desires teaching position in large high school. Holds B.S. degree, with a minor in physics. Forty semester hours in chemistry, including courses in analytical, organic, and physical. Four years teaching experience in Illinois high schools. Also experience as laboratory assistant while attending school. Would prefer position in Illinois or adjoining states. Will accept position in western states if desirably located. Single. Good health. Mason. For further information address, P. O. Box 31, Tremont, Illinois.

Franklin Medal. According to *Nature*, SIR WILLIAM BRAGG, Fullerian professor of chemistry in the Royal Institution and director of the Davy Faraday Research Laboratory, has been awarded the Franklin Medal by the Board of Managers of the Franklin Institute, Philadelphia, "in recognition of a life-work in the study of X-rays and radioactivity, in the course of which he made fundamental contributions to that realm of physics, of his development of a method of determining molecular and crystal structure by the reflection of X-rays and of his fruitful guidance of the Davy Faraday Research Laboratory and the Royal Institution of Great Britain."

Seventh Annual Chemistry Contest. The Seventh Annual Chemistry Contest of the State of Rhode Island will be held in Kingston on May 10th, the same day as the Interscholastic Track Meet. The regulations governing the contest will be the same as in previous years and the type of questions will be similar to those used in past contests. For information regarding last year's contest, see THIS JOURNAL, **6**, 1178 (June, 1929). Inquiries regarding this year's contest should be addressed to PROFESSOR J. W. INCE, Kingston, R. I.

New England Association of Chemistry Teachers. The 121st meeting of the N. E. A. C. T. was held at Brown Uni-

versity, Providence, R. I., on Saturday, March 29, 1930. PROFESSOR W. ALBERT NOYES, of Brown University, spoke on "The New Physics and Physical Chemistry and Their Relationship to the Chemistry Curriculum"; and PROFESSOR STUART R. BRINKLEY, of Yale University, spoke on "Some Problems Confronting the Teacher of Elementary General Chemistry."

Northeastern Ohio Chemistry Teachers Association. The spring assembly of the association was held on April 12th at Western Reserve Academy, Hudson, Ohio. A tour of inspection of the academy as a typical private school was a feature of the program.

California Institute of Technology. According to *Science*, DR. ROBERT ANDREWS MILLIKAN, of the California Institute of Technology, addressed the faculty and student body of Carleton College, on January 9th, under the auspices of the Sigma Xi Club. His subject was "The Alleged Sins of Science."

Colgate University. At a meeting of the senior class, the report of the class gift committee recommending the gift of a dedicatory tablet for McGregory Hall was accepted unanimously.

The tablet has the following inscription: "McGregory Hall, named after Joseph F. McGregory, professor of chemistry in Colgate University from 1884 to 1929, erected upon the foundation created by the will of Mary Evelyn Colgate—died May 22, 1928." (Presented by the class of 1930.)

EDWARD W. TANNER, of Cortland, N. Y., has been awarded a membership in the American Chemical Society by Alpha Nu Chapter of Alpha Chi Sigma. This award is given each year to the member of the chapter who has the highest scholastic record in the junior class.

Work on McGregory Hall is progressing rapidly. The contract calls for the building to be completed June 1st. While some of the equipment will be placed by that time, it is not expected that the building will be ready for occupancy until the opening of college in September.

Columbia University. PROFESSOR MARSTON T. BOGERT as a member of the Central Petroleum Committee, by whom the $500,000 fund donated by John D. Rockefeller, Jr., and the Universal Oil Products Company is allocated in research in the petroleum field, participated in the meeting of the committee at the American Petroleum Institute, 250 Park Avenue, New York City, on March 1st.

PROFESSOR HENRY C. SHERMAN spent the latter half of February in Porto Rico delivering a series of lectures on "The Chemistry of Food and Nutrition," at the School of Tropical Medicine, San Juan, and making, under the auspices of the School, a brief survey of food and nutrition conditions on the Island. On February 25th, he addressed the staff and students of the science departments at the University of Porto Rico, Rio Piedras.

At the forthcoming general meeting of the American Chemical Society, PROFESSOR SHERMAN is scheduled to deliver three research papers dealing with the quantitative chemistry of vitamins A, B, and G, respectively.

PROFESSOR V. K. LA MER gave a lecture at Yale University on Wednesday, March 19th, on "The Application of the Debye-Hückel Theory to Non-Aqueous Solvents."

The department of chemical engineering at Columbia University announces the following courses for the summer session of 1930—a period beginning July 7th and ending August 15th:

*Chemical Engineering s*180—Industrial chemistry, general. PROFESSOR W. D. TURNER. A descriptive course comprising a discussion of the leading chemical industries, illustrated with charts, slides, motion pictures, and exhibits from Chandler Museum.

*Chemical Engineering s*188—Chemical engineering laboratory. PROFESSOR L. T.

WORK and PROFESSOR W. C. WITHAM. A laboratory course comprising a study of the unit operations using semi-factory equipment.

*Chemical Engineering s*297—Research course. PROFESSOR WORK and PROFESSOR TURNER.

For the complete and official 1930 Summer Session Bulletin of Information, address the Secretary, Columbia University, New York City.

Cornell University. The department of chemistry at Cornell will offer instruction in chemical microscopy during the coming summer session of the university. The equipment of the Baker Laboratory affords facilities for the study of instruments and methods used in chemical and industrial microscopy. Two courses will be offered, which will be the full equivalent of those given during the regular college year; they may be taken separately or together, or other work in the department may be carried on, according to the needs of the student.

Fundamental principles and technic of general application will be covered in the introductory course: the manipulation of microscopes and their accessories, microscopic measurements and quantitative analytical methods, crystal studies and physico-chemical phenomena, refractive index determinations, and examinations of textiles, papers, and other industrial materials. A course in microscopic qualitative analysis, including manipulative methods and the reactions of the commoner metals and acids, will also be given.

The summer session will open July 5th, and continue for six weeks, but persons not desiring university credit may arrange to cover, in a shorter period, those portions of the work most suited to their special needs. Any inquiries should be addressed to PROF. C. W. MASON, who will have charge of the courses.

Iowa State College. The fourth meeting of the Ames Section of the A. C. S. was held on February 10th in the chemistry auditorium. DR. S. C. LIND, director of the school of chemistry at the University of Minnesota, addressed the meeting. His topic was "The Contributions of Radioactivity to Chemistry and Physics."

DR. C. W. STEWART, head of the department of physics at the University of Iowa, was the speaker of the evening at the meeting of Sigma Xi at Memorial Union on February 10th. The subject of his talk was "The Liquid State of Matter."

Representatives from several large industrial corporations were visitors on the campus during the past month interviewing prospective graduates. Among them were: DR. E. M. BILLINGS, of the Eastman Kodak Company; MR. H. S. VAN BUREN, of Procter and Gamble Company; and DR. A. A. WELLS, of the Standard Oil Company, New Jersey.

DR. J. A. WILKINSON is now president of the Iowa State College Chapter of Phi Kappa Phi. He takes the place of MISS P. MABEL NELSON, who recently resigned.

The Maize Wood Products Corporation of Dubuque, Iowa, has been reorganized and is now a subsidiary of The Cornstalk Processes, Inc. DR. O. R. SWEENEY is consulting engineer and a member of the board of directors.

The Pathé News was in Ames recently and made some sound newsreels of the Chemical Engineering Insulating Board Plant, at which time DR. O. R. SWEENEY explained the process. Pictures of the Campanile were also taken.

The Bureau of Standards, in conjunction with the chemical engineering department, is carrying out some experiments leading to the production of insulating board from artichoke stalks.

"An Introduction to the Chemical Action of Micro-Organisms on the Non-Nitrogenous Organic Compounds," by E. I. FULMER and C. H. WERKMAN, assisted by ANELLA WIEBEN and C. R. BREDEN, is soon to be published by C. C. Thomas, Publisher, Springfield, Illinois.

Johns Hopkins University. The chemistry department of The Johns Hopkins University has just announced the second annual quota of fellows selected under the National Fellowship Plan established last year. The plan provides ultimately for the establishment of one fellowship from each of the forty-eight states of the Union. There are in addition two National Fellowships-at-large and one International Fellowship for England.

The fellows newly selected by the respective State committees are as follows:

William Shallcross Speed Fellowship: THOMAS CROSS, JR., University of Kentucky, Lexington, Kentucky.

U. S. Industrial Alcohol Co. Fellowship: DONALD L. ZINK, Louisiana State University, Baton Rouge, Louisiana.

General Motors Corporation Research Laboratories Fellowship: ARTHUR L. GLASEBROOK, University of Michigan, Ann Arbor, Michigan.

Hormel Foundation Fellowship: WALTER O. LUNDBERG, University of Minnesota, Minneapolis, Minnesota.

G. A. Pfeiffer Fellowship: LLOYD B. THOMAS, University of Missouri, Columbia, Missouri.

John M. Hancock Fellowship: DONALD L. FARNHAM, University of North Dakota, Grand Forks, North Dakota.

John Wiley and Sons, Incorporated, Fellowship: DONALD A. WILSON, Geneva College, Beaver Falls, Pennsylvania.

Du Pont Fellowship: CLARENCE P. ELY, University of Richmond, Richmond, Virginia.

Fleischmann Fellowship: WILLIAM REDMOND JOHNSTON, University of Washington, Seattle, Washington.

Carbide and Carbon Chemicals Corporation Fellowship: HENRY C. CHITWOOD, West Virginia University, Morgantown, West Virginia.

Patrick Garvan Memorial Fellowship-at-large: THEODORE L. BROWNYARD, Massachusetts Institute of Technology, Cambridge, Massachusetts.

The English Fellowship will not be awarded until later in the year.

Each fellow receives one thousand dollars annually while studying for his degree at The Johns Hopkins University.

The course of instruction outlined for them emphasizes fundamental training in mathematics, physics, and English, as well as in the four major branches of chemistry (inorganic, organic, physical, and analytical). A broad fundamental training is the objective.

The plan also provides for contact with prominent chemists, both American and foreign, under a special lectureship established by Dr. A. R. L. DOHME, of Sharp & Dohme.

To date twenty-five fellowships have been established. They are as follows.

Eli Lilly Company, Indianapolis, Indiana.

Firestone Tire and Rubber Company, Akron, Ohio.

Francis P. Garvan, given at large.

J. T. Baker Chemical Company, Phillipsburg, New Jersey.

H. A. B. Dunning, Baltimore, Maryland.

The Bill Raskob Foundation, Wilmington, Delaware.

The Brown Company, Berlin, New Hampshire.

The Brown Company, Portland, Maine.

The Kewaunee Manufacturing Company, Kewaunee, Wisconsin.

The General Motors Corporation Research Laboratories, Detroit, Michigan.

The Carbide and Carbon Chemicals Corporation, West Virginia.

The Fleischmann Company, Washington.

William Shallcross Speed, Louisville, Kentucky.

Patrick Garvan, given at large.

Mary Carroll Garvan, given at large.

John Wiley and Sons, Incorporated, Pennsylvania.

U. S. Industrial Alcohol Company, Louisiana.

Hormel Foundation, Austin, Minnesota.
E. I. du Pont de Nemours & Company, Virginia.
John M. Hancock, North Dakota.
Frederick G. Donnan, England.
G. A. Pfeiffer, Missouri.
American Can Company, California.
American Can Company, Oregon.
American Can Company, Utah.

Kansas State Agricultural College. DR. CHARLES A. KRAUS, of Brown University, Providence, Rhode Island, addressed the Kansas State College Section of the A. C. S., Thursday evening, March 6th, on the subject, "What Has Been Learned from a Study of Liquid Ammonia Solutions." There were 150 students and professors in attendance at the lecture. Dr. Kraus was a former Kansan, having lived at Hays, Kansas, during his boyhood, and having attended the University of Kansas, from which institution he received his baccalaureate degree.

Lafayette College. The local chapter, Alpha Mu, of Alpha Chi Sigma has voted to instal, at some suitable location in the chemistry building, a plaque for the purpose, indicated by caption on the plaque, of honoring that member of the graduating class who has earned the B.S. degree in chemistry or chemical engineering or has majored in chemistry and... "who throughout his college career has given evidence of the most outstanding qualities of scholarship, originality, and character." The name and class numerals of the winner of this honor, selected annually from the graduating class by proper procedure, is to be permanently inscribed on the plaque. This is the second constructive effort of the Alpha Mu Chapter to create personal reward and encouragement—other than by election to membership—for Lafayette students who do distinguished work in the field of chemistry. Several years ago the chapter established an annual double prize of a silver cup and a limited value in chemistry books (selected by the winner of the cup) to be awarded, by a suitable committee, to that student in general elementary chemistry who makes the best record in the course throughout the year.

The first public meeting to be held in the new Markle Hall, the recently dedicated mining engineering building representing about half of the recent million dollar gift to Lafayette College by JOHN MARKLE, was the meeting sponsored by the John Markle Mining Society of Lafayette College on Tuesday evening, March 11th. The speaker for this occasion was DR. GEORGE F. KUNZ, internationally known gem expert and vice-president of Tiffany & Company of New York, whose talk on the popular and interesting subject, "The Mining, Cutting, and Distribution of Precious Stones—Past, Present, and Future," was illustrated by slides.

Massachusetts Institute of Technology. In the summer session (July 7th–August 1st) of the Massachusetts Institute of Technology, a course will be given in Methods of Teaching Chemistry in Senior High Schools. DR. WALTER C. SCHUMB, associate professor of inorganic chemistry, will be the instructor.

The Ohio State University. PROFESSOR W. L. Evans addressed the Rochester Section of the A. C. S. on February 24th, and the graduate students in chemistry of Yale University on February 25th. His address was on "Recent Advances in Carbohydrate Chemistry."

MR. J. L. BUSSIES received his Ph.D. degree at the March convocation. Mr. Bussies has accepted a position as chemist with the Standard Oil Company of Whiting, Indiana. MR. J. F. LEWIS, who also received his doctor's degree in March, has located in Detroit as a consulting chemist.

DR. H. L. JOHNSTON, of the department of chemistry, was one of the three recipients of the $150 prize awarded by the Pacific Division of the American Association for the Advancement of Science. The other two persons thus honored were

DR. W. F. GIAUQUE, of the University of California, and H. D. BABCOCK, of the Mt. Wilson Observatory. The award was for their work on the existence in small proportions of the two isotopes of oxygen, masses 17 and 18.

The department of chemistry has been represented before the Ohio School of the Air as follows: February 11th, "Gas and Its Products," DR. C. E. BOORD; February 25th, "Motor Fuels," DR. C. E. BOORD; March 11th, "Bases, Acids, and Salts," DR. W. C. FERNELIUS.

PROFESSOR and MRS. W. R. BRODE will spend the next two months on an automobile vacation trip into Washington. Professor Brode will teach organic chemistry at the University of California during the summer term.

According to *Science*, DRS. T. M. LOWRY, of Cambridge University, and R. A. MORTON, of the University of Liverpool, will be visiting professors on the faculty of chemistry of the Ohio State University during the coming summer quarter. Dr. Lowry will offer courses on optical activity in organic compounds and also on the physical basis (mainly spectroscopic) for chemical theory. Dr. Morton will offer a series of lectures in photochemistry. PROFESSOR H. A. WILSON, of the Rice Institute, and PROFESSOR W. W. WATSON, of Yale University, will also be in residence during the summer quarter. Professor Wilson will lecture on the conduction of electricity through gases and the application of thermodynamics to chemical problems, and Professor Watson on molecular spectra and related topics.

Pennsylvania State College. DEAN FRANK C. WHITMORE, of the School of Chemistry and Physics, addressed the Pittsburgh Section of the A. C. S. on April 17th, on the subject, "Modern Tendencies in Industrial Organic Chemistry." He has recently given similar talks on this subject before the Northeastern and the Philadelphia Sections of the Society.

Princeton University. On Thursday evening, March 6th, DR. H. L. FISHER, of the United States Rubber Co., addressed the Chemical Club on the topic, "Rubber from Plantation to Industry." The lecture was illustrated with motion pictures.

At recent chemical colloquia the following papers were read:

"The Mechanics of the Chemical Bond," DR. D. H. ANDREWS, of The Johns Hopkins University, Thursday, February 20th.

"Dehydration and Rehydration," PROFESSOR A. W. C. MENZIES, Tuesday, February 25th.

"London's Theory of Reaction Velocity," DR. E. P. WIGNER, Tuesday, March 4th.

"New Developments in Volumetric Analysis. Adsorption Indicators and Oxidation-Reduction Indicators," PROFESSOR N. H. FURMAN, Wednesday, March 12th.

Southern Illinois State Normal University. On February 26th, the new chemistry building of the Southern Illinois State Teachers College, located at Carbondale, Illinois, was formally opened. In the forenoon, a dedicatory address was delivered to the student body by PROF. J. H. REEDY of the University of Illinois. Dr. Reedy's address was on "Mysticism in Modern Chemistry." In the afternoon, the laboratories were open for public inspection. In addition there were many demonstrations and exhibits by students taking advanced courses in chemistry.

The building is 78 feet by 175 feet and is three stories high. The entire second floor and part of the first are devoted to chemistry. There are five laboratories: one for beginning freshmen, one for advanced freshmen and qualitative analysis, one for quantitative analysis and physical, one for organic and one for faculty research. These laboratories are all completely equipped and give ample facilities for handling the yearly enrolment in chemistry courses which is approximately 700 students.

There are five members on the teaching staff of this department. They are: J. W. NECKERS, Ph.D., University of Illinois, head of the department; GEO. M. BROWNE, graduate, Massachusetts State Normal, Westfield, Mass.; R. A. SCOTT, M.S., University of Illinois; T. W. ABBOTT, Ph.D., University of Illinois; and C. C. LOGAN, B.S., University of Illinois.

State University of Iowa. PROFESSOR L. CHARLES RAIFORD, of the University of Iowa, will give special lectures in organic chemistry at Western Reserve University during the summer session of 1930.

PROFESSOR and MRS. EDWARD BARTOW returned to Iowa City on March 5th, after a five months' trip around the Pacific. They visited Japan, China, the Philippines, Java, Australia, and New Zealand.

G. M. MCNULTY, who expects his Ph.D. degree in the summer of 1930, has accepted a position with the Standard Oil Company of Whiting, Ind.

DR. H. E. HOWE, editor of *Industrial and Engineering Chemistry*, visited the university on March 20th, and lectured before the Iowa Section of the A. C. S.

The following attended the meetings of the Federation of Biological Sciences at Chicago, March 25th–29th: DRS. H. A. MATTILL, E. W. ROCKWOOD, R. B. GIBSON, H. G. SMITH, and C. P. BERG; and MR. J. W. CAVETT, ADRIAN KUYPER, H. S. OLVOVICH, MISS MARTHA POTGIETER, and MISS MARY E. TURNER. Papers were presented by Dr. Berg and Mr. Cavett.

Tufts College. On the evening of April 25th, from 7.30 to 10 P.M., the Tufts College Chemical Laboratory will be open as usual to visitors. A number of students will act as guides through the building while others will be engaged in experimental work illustrating phases of the courses which lead to the B.S. in chemistry and B.S. in chemical engineering degrees.

Scattered through the four floors of the laboratory will be exhibited all of the standard equipment necessary for the proper execution of chemical investigations. A wide range of experimental work in analytical, organic, industrial, metallurgical, and physical chemistry is in progress, and research as carried on by undergraduate and graduate students and instructors will be in evidence.

Opportunity will then be provided for graduates and friends of the college to become familiar with the college laboratory while a large portion of the actual student work is in progress. It will also enable prospective students to obtain the information which is so necessary and vital in choosing a college and course of study.

The University of Arizona. DR. L. E. ROBERTS, who has sabbatical leave this semester, sailed for Germany the first of February. He will spend the next six months doing work in the field of physical chemistry at the University of Berlin.

DR. T. F. BUEHRER, who has been a member of the chemistry department of the University of Arizona for the last eight years, has recently transferred to the department of agricultural chemistry. He will spend practically all of his time on research, teaching only a few classes a year.

MR. KENNETH L. BIRD, who has been doing graduate work with DR. MCBAIN at Stanford University, is temporarily filling the position left vacant by Dr. Buehrer.

DR. I. GRAGEROFF, director of the Apache Powder Works at Benson, Arizona, is chairman of the Arizona Section of the A. C. S. for the coming year. Through his influence, the February meeting was held on the grounds of the Powder Works, on Saturday, the twenty-second. Since the plant was not in operation, the forty-seven members and friends attending the meeting were taken through the entire concern, including the units in which nitroglycerin is made, transformed into dynamite, and put into cartridges, and the spent acids recovered and nitric acid manufactured. They were guests of the Apache Powder Co. at luncheon, and in

the afternoon were given a demonstration of the various tests applied to the completed nitroglycerin and dynamite.

DR. H. E. HOWE, editor of *Industrial and Engineering Chemistry*, spoke before a special meeting of the Arizona Section on Friday, February 28th. His subject was "Chemistry in Industry."

University of Arkansas. DR. HARRISON E. HOWE, editor of *Industrial and Engineering Chemistry*, was a visitor at the university from March 11th–13th. He addressed a general convocation of the university on the morning of March 13th on the subject "Discoveries of Tomorrow," displaying recent chemical products. He was also the chief speaker at a joint dinner of the Fayetteville Chamber of Commerce, the Lions Club, and the Rotary Club. The local chapter of the Alpha Chi Sigma Chemical Fraternity was present in a body. Dr. Howe's address after the dinner was on the subject, "Science in the New Competition."

"Al Chimia Club" is the name of the new club to which all students and faculty members in the department of chemistry are eligible. Its first banquet was held on March 12th with Dr. Howe as the guest of honor.

March 14th was Engineers' Day at the University of Arkansas. The speaker at the engineering convocation was DR. O. M. LELAND, dean of the college of engineering and architecture and of the school of chemistry at the University of Minnesota. During the afternoon, the exhibits in the chemistry building, arranged and displayed by the students in chemical engineering, brought large numbers of interested visitors to the laboratory.

University of Chicago. IRA DERBY, Ph.D., 1910, is no longer connected with the Republic Creosoting Company, Indianapolis, but is director of research, Riley Laboratories, Indianapolis, Indiana.

DR. CALVIN S. FULLER is now employed at the Bell Telephone Laboratories, New York City.

At the March convocation, the Ph.D. degree was conferred upon RUSSEL B. COOPER, OLIVER G. VOGEL, and ALBERT W. MEYER; G. MOREY and MISS BERTIE WARREN received the degree of M.S.

The March Seminar meetings were held in the Jones Laboratory in the early and latter parts of the month. At the physical chemical meeting, PROFESSOR HOGNESS led the discussion on the subject of photochemistry, band spectra, and *ortho* and *para* hydrogen. The latter meeting was directed by DR. JAMES SENIOR and MR. LE GAULT. Dr. Senior discussed some new phases of stereochemistry, while MR. LE GAULT selected free methyl as his topic.

DR. MARY RISING and DR. T. F. YOUNG have returned from their vacations in California for the opening of the spring quarter.

MISS PEARL HILL has returned to the university to complete her work for the Master's degree. MISS B. KNAPP has also returned to continue graduate study.

University of Florida. A short course in Water and Sewage Treatment will be offered by the General Extension Division of the University of Florida, April 8–11, 1930. This course is offered in coöperation with the Florida State Board of Health and the Florida Section of the American Water Works Association and will be given under the direction of a committee composed of members of the university faculty and officials of these two organizations. The instruction will be given by faculty members from the departments of botany and bacteriology, chemistry, and civil engineering of the University of Florida, assisted by the following visiting professors, prominent government and state officials, and practicing engineers in the fields of water and sewage treatment:

E. B. BESSELIEVRE, director of the Sanitary Engineering Division, The Dorr Company, New York, N. Y.

PAUL EATON, director of laboratories, Florida State Board of Health, Jacksonville.

L. H. ENSLOW, research engineer, The Chlorine Institute, New York, N. Y.

ARTHUR E. GORMAN, The Wallace & Tierman Company, Chlorine Control Apparatus, Newark, N. J.

HERMAN GUNTER, Florida State Geologist, Tallahassee, Fla.

R. E. TARBETT, sanitary engineer, United States Public Health Service, Washington, D. C.

PROFESSOR EDWARD BARTOW, head of the chemistry department, University of Iowa, Iowa City, Iowa.

The meeting of the Florida Section of the A. C. S. was held in the George Washington Hotel, Jacksonville, Florida, on February 24th. The section held its meeting as one of the group meetings of the International Naval Stores Conference, which was held in Jacksonville, February 24th–26th, under the auspices of the Pine Institute of America, Inc. The program was as follows:

"Industrial Research at Mellon Institute," by DR. GEORGE D. BEAL, assistant director, Mellon Institute of Industrial Research, Pittsburgh, Pa.

"Research Work of the U. S. Department of Agriculture of Especial Importance to the South," by DR. W. A. SKINNER, assistant director, Division of Chemical and Technological Research, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

"Chemistry as a Creative Science," Dr. HENRY G. KNIGHT, chief of the Bureau of Chemistry and Soils, U. S. Department of Agriculture.

Other prominent guests present at the conference included: MR. LUCIEN MEMMINGER, French Consul; DR. CHARLES H. HERTY, New York; MAJOR R. Y. STEWART, Chief of the Forest Service, U. S. Department of Agriculture; MR. C. C. CONCANNON, Chief of the Chemical Division, Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce; and DR. JULIUS KLEIN, Assistant Secretary of Commerce. Dr. Klein's address, "The New Industrial South," was broadcast over a coast-to-coast hook-up on Tuesday evening.

Following the close of the convention, Dr. Skinner, Dr. Knight, Dr. Concannon and others visited Gainesville and the University of Florida.

University of Kansas. DR. S. C. LIND spoke at the February meeting of the Kansas City Section, A. C. S., on the subject of "The Action of Alpha Rays on Hydrocarbons."

DR. CHARLES A. KRAUS, of Brown University, spoke before the Kansas City Section of the A. C. S. on March 5th, on the subject, "The Border Line between Organic and Inorganic Chemistry."

DR. A. W. DAVIDSON, of the chemistry department of the University of Kansas, and DR. W. H. MCALLISTER, of Procter and Gamble, are the authors of the two following articles which appeared in the February number of the *Journal of the American Chemical Society:* "Solutions of Salts in Pure Acetic Acid. II. Solubilities of Acetates;" and "Solutions of Salts in Pure Acetic Acid. III. Zinc Acetate and Sodium Zinc Acetate."

DR. H. C. ALLEN, of the chemistry department of the University of Kansas, has had the following articles published: "Analyses of Some Natural Gasoline Gases before and after Treatment," in the October 15th issue of *Industrial and Engineering Chemistry;* and "Chemistry Reveals Important Facts," in the October 24th issue of the *Oil and Gas Journal.*

DR. H. P. CADY, DR. MARY ELVIRA WEEKS, of the University of Kansas, and the late PROFESSOR GEORGE KEMMERER, of the University of Wisconsin, are the authors of an article, "The Rôle of Hydrogen-Ion Concentration in the Precipitation of Calcium and Magnesium Carbonates," which appeared in *The Journal of Physical Chemistry,* **33**, 1929.

University of Missouri. On February 25th, a general meeting of the local chapter

of Sigma Xi was held in the new chemistry building, at which DR. HERMAN SCHLUNDT, chairman of the department of chemistry, spoke on the "Evolution of the Atom," and DR. A. G. HOGAN, chairman of the department of agricultural chemistry, spoke on "Nutrition."

On Tuesday evening, March 4th, the University of Missouri Section of the A. C. S. had as its guest, DR. CHARLES A. KRAUS, head of the department of chemistry of Brown University, Providence, Rhode Island. Following the dinner, which was held in his honor, Dr. Kraus spoke in the lecture room of the new chemistry building, on "The Boundary between Organic and Inorganic Chemistry."

Each year the University of Missouri chapter of Sigma Xi and the chapter at Lawrence, Kansas, exchange lecturers. This year the exchange lecture was given by DR. HERMAN SCHLUNDT, whose subject was "Radium Poisoning."

University of Pennsylvania. On the afternoon of May 23rd, at 4 o'clock, DR. CHARLES A. KRAUS, director of the department of chemistry at Brown University, will deliver the Edgar F. Smith Birthday Lecture at the Harrison Laboratory of Chemistry, University of Pennsylvania. His subject will be "The Properties of Electrolytes as a Function of the Constitution of Their Anions."

University of Pittsburgh. PROFESSOR ALEXANDER SILVERMAN, head of the chemistry department of the University of Pittsburgh, addressed the University of Wisconsin on the afternoon of March 19th on "Educational and Research Institutions of Europe," and the Madison Section of the A. C. S. on the evening of March 19th on "Recent Developments in Glass Manufacture." Professor Silverman also addressed the Milwaukee Section of the A. C. S. on "Recent Developments in Glass Manufacture," on the evening of March 21st.

During the summer session of 1930 graduate courses in quantitative organic microanalysis and chemical microscopy will be offered. These courses will be under the direction of DR. E. V. HJORT, who has charge of chemical microscopy, and DR. MARTIN E. MCGREAL, who spent the past summer with DRS. PREGL and EMICH, who are European authorities in this field.

University of Virginia. A group of twenty students, composed largely of men from the graduate school, participated in an inspection trip of four outstanding chemical industries located at Hopewell, Va., on February 14th. The industries visited included a 100-ton pulp and paper mill, the largest air-nitrogen plant in the western hemisphere, a 100-ton cotton cellulose plant, and a china factory. The group returned to the university via Richmond, where they attended a meeting of the local section of the A. C. S. which was addressed by DR. GUSTAVE J. ESSELEN, JR., on the subject of cellulose products in Virginia.

The Alpha Kappa Chapter of Alpha Chi Sigma held a field day on Feb. 27th, which was attended by nearly 200 students of chemical courses. This program consisted of two portions, designed to furnish entertainment in chemical form and composed of what was considered the best of several similar programs at other institutions and section meetings. The program included two serio-comic scientific presentations, a motion picture of Thomas Jefferson, a liquid air demonstration, and the rest of the evening was devoted to competing in a series of field events which served to stimulate youthful interest in chemical subjects ranging from the names of the least-known elements to the names of still less known specimens of chemical apparatus. Prizes in the form of chemical texts distributed by the Chemical Foundation were awarded to the best guessers.

The local Alpha Chi Sigma Chapter has announced an A. C. S. membership to be awarded in June to the outstanding

junior in chemistry and chemical engineering. The membership is to commence the following January.

University of Wisconsin. That interest is being sustained in the Prize Essay Contest conducted among the high schools of the state is evident from an examination of the entries for the past three years. In 1928, 129 essays were submitted. The following year a gain of five is noted while the 1930 contest brought before the committee a total of 128.

In seeking an answer to the question, "What rôle have chemists played in the activities of the Wisconsin Chapter of the Society of the Sigma Xi," the following data have come to light: During the course of its 118 meetings, 179 papers have been presented before the chapter. Of this number, 20 per cent have been read by chemists or chemical engineers. PROFESSOR RICHARD FISCHER was the first of this group to have presented a paper, his appearance on the program of May 4, 1907, with a paper entitled "The Manufacture of Yellow Oleomargarine without the Use of Extraneous Coloring Matter," marking the initial meeting of the local chapter. Other speakers have been C. F. BURGESS, E. V. MCCOLLUM, H. C. BRADLEY, the late A. S. LOEVENHART, EDWARD KREMERS, E. B. HART, J. H. WALTON, O. L. KOWALKE, the late VICTOR LENHER, J. H. MATHEWS, FARRINGTON DANIELS, LOUIS KAHLENBERG, L. F. HAWLEY, E. L. SEVRINGHAUS, H. D. BAERNSTEIN, O. P. WATTS, and RICHARD FISCHER have each presented one paper. Guest speakers have been HERBERT FREUNDLICH of Germany, THE SVEDBERG of Sweden, W. MANSFIELD CLARK of Johns Hopkins, and I. M. KOLTHOFF of the University of Minnesota.

The presidency has been held by C. F. BURGESS (1912), VICTOR LENHER (1921), H. C. BRADLEY (1923), and F. C. KRAUSKOPF (1925). H. A. SCHUETTE is the present incumbent.

PROFESSORS EDWARD KREMERS and WILLIAM RICHTMANN, MR. W. ENZ, MR. SAM CHECHIK, and MR. C. O. LEE plan to attend the meeting of the American Pharmaceutical Association in Baltimore, Maryland, the week of May 5th. Following the meeting, the party will attend the sessions of the United States Pharmacopeia Revision Convention which will convene in Washington during the week of May 13th. Professors KREMERS and RICHTMAN are the Wisconsin delegates to this convention.

Vanderbilt University. The American Cast Iron Pipe Company, of Birmingham, Alabama, has established a fellowship at this university in the general field of metallurgy. The fellowship pays $800 and will be continued over a period of years.

Wake Forest College. *The Ray of Gamma Sigma Epsilon* reports that a loving cup was presented by Alpha Gamma chapter to the department of chemistry of Wake Forest College. On it will be engraved each year the name of the freshman making the highest grade in chemistry.

Wesleyan University. PROFESSOR C. ALBERT HILL has been elected as substitute councilor for the Connecticut Valley Section of the A. C. S. for the meeting at Atlanta.

Williams College. PROFESSOR K. FAJANS, director of physical chemistry at the University of Munich, Germany, lectured on the elementary theory of chemical forces before a large audience in Thompson Chemical Laboratory, Williams College, on March 10th. Professor Fajans is in this country as the holder of the George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University during this semester. [See THIS JOURNAL, 7, 707 (March, 1930).] Before returning to Germany in June, Dr. Fajans will lecture before the leading scientific schools in the United States and Canada.

Ames Section, A. C. S. *See* **Iowa State College.**

Arizona Section, A. C S. *See* **The University of Arizona.**

Cincinnati Section, A. C. S. A social meeting of the Cincinnati Section, A. C. S., was held Wednesday, March 12, 1930, at 8.00 P.M., in the auditorium of the chemistry building of the University of Cincinnati.

Connecticut Valley Section, A. C. S. *See* **Wesleyan University.**

Delaware Section, A. C. S. At the meeting of the Delaware Section, A. C. S., on March 19, 1930, DR. CARL VOEGTLIN, of the U. S. Public Health Service, spoke on "Chemotherapy and Organic Arsenicals."

Florida Section, A. C. S. *See* **University of Florida.**

Indiana Section, A. C. S. BENJAMIN COHEN, of Indiana University, has been awarded the first student membership in the American Chemical Society by the Indiana Section. Two of these awards are made each year by the section to the highest ranking senior from two of the six leading colleges in the Indiana section. The award is based on three and one-half years work in chemistry and is recommended by the head of the department of the college.

Mr. Cohen is a graduate of Medill High School of Chicago, and prior to entering Indiana University, attended Crane Junior College of Chicago, for a year and a half. He is a member of Phi Beta Kappa, Phi Lambda Upsilon and Sigma Alpha Mu fraternities and will graduate this June "with high distinction."

Iowa Section, A. C. S. *See* **State University of Iowa.**

Kansas City Section, A. C. S. *See* **University of Kansas.**

Kansas State College Section, A. C. S. *See* **Kansas State Agricultural College.**

Madison Section, A. C. S. *See* **University of Pittsburgh.**

Milwaukee Section, A. C. S. *See* **University of Pittsburgh.**

New York Section, A. C. S. The William H. Nichols Medal was presented to the 1930 recipient, DR. SAMUEL E. SHEPPARD, of the Eastman Kodak Co., at the meeting of the New York Section, A. C. S., on March 14, 1930. The following was the presentation program:

"Scientific Career of the Medallist," C. E. K. MEES, director, Eastman Kodak Co.

"A Futuristic Study of the Medallist," PROFESSOR W. D. BANCROFT, Cornell University.

Presentation of Medal. PROFESSOR R. R. RENSHAW, New York University.

Acceptance. "The Reactions of Photographic Material to Light," DR. SAMUEL E. SHEPPARD, Eastman Kodak Co.

North Jersey Section, A. C. S. At the meeting of the North Jersey Section, A. C. S., DR. E. L. JORGENSEN, of Irvington Smelting and Refining Works, Irvington, N. J., spoke on "Metallurgy and Hydrometallurgy in South America," illustrating his talk with lantren slides and motion pictures.

Northeastern Section, A. C. S. At the 243rd meeting of the Northeastern Section, A. C. S., which was held at the American Academy of Arts and Sciences, Boston, Massachusetts, on March 14th, PROFESSOR KASIMIR FAJANS, of the University of Munich, Germany, spoke on "Chemical Forces and Atomic Structure." Professor Fajans is the George Fisher Baker Non-Resident Lecturer in Chemistry at Cornell University.

Philadelphia Section, A. C. S. A meeting of the Philadelphia Section, A. C. S., was held on March 20th. DR. J. B. CONANT, of Harvard University, spoke on

"Recent Triumphs and Future Problems of Organic Chemistry."

Pittsburgh Section, A. C. S. At a meeting of this section at the Bureau of Mines on March 17, 1930, DR. G. E. F. LUNDELL spoke on "Analytical Chemistry of Today." Dr. Lundell is in charge of the analysis of ores and ferrous and nonferrous metals at the U. S. Bureau of Standards, where he has directed the preparation and analysis of the U. S. Bureau of Standards analyzed samples. Before joining the Bureau of Standards, Dr. Lundell was assistant professor of analytical chemistry at Cornell University, where he served from 1912 to 1916.

Rochester Section, A. C. S. *See* **The Ohio State University.**

South Jersey Section, A. C. S. On March 12, 1930, DR. K. S. GIBSON, of the Bureau of Standards, spoke before the South Jersey Section, A. C. S., on the subject, "The Specification of Color."

University of Missouri Section, A. C. S. *See* **University of Missouri.**

Chemistry Develops Perfume Industry. Through modern chemistry the making of perfume, formerly confined to a few countries in Europe, where it has been closely associated with mass cultivation of flowers for production of essential oils, has grown to such proportions in the United States as to be classed as an industry, according to the Chemical Division of the Department of Commerce, and most foreign resistance is being overcome. Contributing largely to domestic production of perfume has been the development of synthetic aromatic chemicals. These aromatics so closely imitate, and in some cases accentuate, the natural flower odors that many of them have become essential ingredients in the blending of the better natural perfumes, as well as the cheaper artificial product.

Production of perfumes in the United States has grown from an output valued at approximately $2,000,000 in 1914 to more than $15,000,000 in 1927, the last year for which figures are available. From an importer of finished perfumes the nation is changing steadily to an importer of perfume materials needed to augment the synthetic aromatics in perfume making, according to the Chemical Division.

Imports of specified perfume materials have shown an upward trend in the last five years, while the imports of finished perfumery and toilet waters have declined steadily. Imports of essential and distilled oils, which include the natural flower oils such as geranium, rose, lavender, jasmine, etc., and the oils obtained from fruits and plants, such as lemon, orange, bergamot, clove, eucalyptus, and sandalwood, also have showed gains, the imports of these oils for the first nine months of 1929 totaling $5,807,558 compared to $5,001,765 in the previous corresponding period, or a gain of 16 per cent.

These imports of essential oils are utilized only in part in perfume making, large quantities entering into the manufacture of soaps, dentifrices, and other toilet preparations. The increased use, however, of these natural odoriferous oils is due in large part to the development of the synthetic aromatic and the growth of the domestic perfume industry, the natural oils being employed in the blending of the synthetic ingredients to give delicacy to the artificial product.—*Ind. Eng. Chem.*

A great life can be traced by the bridges it has made for the pathway of men.—WILLIAM FREDERICK BIGELOW

Recent Books

Elementary Inorganic Chemistry. J. W. MELLOR, D.Sc., F.R.S. Longmans, Green & Co., New York City, 1930. x + 229 pp. 7 tables, 129 figures, including 5 photographs. 13 × 19 cm. $1.50.

This book is a study of some of the common non-metallic elements from a non-formula and non-mathematical viewpoint. A few equations are included but these are balanced and seem to have no special purpose except to show the student that such things are used.

The book is divided into 17 chapters in which the following subjects are covered: Air, H_2, O_2, N_2, Mixtures and Compounds, Atomic Hypothesis, H_2O; Chlorides and Cl_2; Acids, Bases, and Salts; Carbonates, CO_2, Combustion and Flame, Sulfur and Its Compounds, Nitrates, Nitric Acid, Ammonia, Phosphorus.

From this list it can be seen that the field covered is very limited. The material is taken up in Mellor's characteristic manner. Sufficient history is included to give a personal touch to the subject matter.

It seems unfortunate that Dalton's Atomic Hypothesis is given as the last word in the structure of matter even in this elementary discussion. The material usually covered under the metals and under organic chemistry is not considered at all. Equivalent weights are discussed but valence is not mentioned.

The author apparently intends to give just an insight into the beginning of the study of chemistry, and he does this admirably. The topics are well presented and the book is written so that it may be understood without the aid of an instructor.

This is an excellent book for a short course where descriptive material is desired, or it may be used as an introduction to a more difficult presentation.

C. E. WHITE

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COLLEGE PARK, MD.

Instructional Tests in Chemistry for High Schools and Colleges. Consists of three pamphlets: (1) Student's Booklet, (2) Teacher's Manual, and (3) Key. EARL R. GLENN, New Jersey State Teachers' College, Montclair, New Jersey; LOUIS E. WELTON, John Hay High School, Cleveland, Ohio. World Book Company, Yonkers-on-Hudson, New York, 1930. iv + 76 pp. 36 illustrations. 16 × 25 cm. Price: (1) Student's Booklet, $0.36, (2) Teacher's Manual, $0.16, (3) Key, $0.16.

The authors state, in the Teacher's Manual which accompanies the Student's Booklet, that the tests are to be used in improvement of learning in chemistry by identifying the students' learning difficulties; by revealing the student's errors in explanations, problems, uses of technical vocabulary, etc.; by frequent and rapid survey of students' progress; by giving the teacher information for devising necessary remedial drill work; by showing the nature of the students' achievement; and by investigations of the above data, "make a beginning in the formulation of the psychology of learning chemistry."

The book contains 36 tests which may be used in any desired order and are short enough to be given and corrected in class, in a school period. In general, each test consists of multiple choice, matching, modified true-false, completion, brief answers, and vocabulary questions.

The instructions for giving the tests are definite. Two pages in the back of each book give the student a place to record the time he has used in taking the test, his separate scores, and his rate of progress. Suggestions are offered to aid the teacher in interpreting the tests. A table of tentative norms, given in percentile ranks, and reliabilities is found in the teacher's manual.

Each test covers a unit of work. The range of questions shows a thorough

study of the content of current chemistry textbooks. One is surprised to find that several errors which have crept into the texts have been retained by these authors. Such mistakes as designating *density* as a *pure number*, giving the *weight* of a *molecule*, and using the long ago discarded term of *water of crystallization*, are typical. Some questions are ambiguous. In spite of these minor defects every teacher will find that merely reading the tests gives him a fair conception of what is now being taught and what learned in chemistry. The modified true-false type of question in which the student is required to not only indicate the false statement but to correct it will make a special appeal to those teachers to whom testing is something more than a measuring device.

HATTIE D. F. HAUB
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The Terminology of Physical Science. DUANE ROLLER. University of Oklahoma Press, Norman, Okla., 1929. 116 pp. 14 × 22 cm. $1.00.

This interesting little book is to the terminology of physical science as Crabb to the English language in general. The terms considered include those that are meaningless or ambiguous, those that should be discarded because better words are available, those that require precise definition because of inaccurate popular usage, and those that are so similar as to be readily confused. Following this glossary is a list of prefixes and suffixes and a chapter devoted to the origin and meaning of the names of the chemical elements. Mistakes in pronunciation, correct spelling, and the principles of abbreviation are then considered. Terms from physics and physical chemistry receive more attention than purely chemical terms. The rules of the American Chemical Society on spelling and pronunciation might well have been included.

Readers who have given little thought to scientific terminology will be startled to note how many terms are like the human appendix in being vestigial inheritances from a more primitive stage of evolution. The problem of getting rid of them is made easier by directing attention to them. Every editor or writer in the field of physics and chemistry should consider the suggestions of this little manual very carefully. Students would profit by having the distinction between similar terms brought to their attention at an early stage in their training.

Yet the benefits that any one may acquire from stricter attention to details of this sort is not to be had apart from risk. A young lady, just recovered from smallpox, was shunned by her friends—not because of physical disfigurement by the disease, but because she had devoted spare moments while in quarantine to studying "Five Thousand Words Commonly Mispronounced." This gave her a sense of superiority that made her unpopular.

HORACE G. DEMING
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Qualitative Analysis. C. J. BROCKMAN, Associate Professor of Chemistry, University of Georgia. Ginn & Co., Boston, Mass., 1930. x + 197 pp. Tables. 15½ × 23 cm. $2.20.

The purpose of this book is to present a method of qualitative analysis without the use of hydrogen sulfide, and the scope of the scheme covers the cations and anions usually included in the ordinary textbooks in this field of chemistry.

While the reviewer has not had occasion to try out the method so that he can compare it with the conventional one, he finds the object of the author praiseworthy and of considerable interest. Such a departure from the beaten track has often been discussed, but so far as the reviewer knows, this is the first textbook which has seriously placed it before the hydrogen-sulfide-gassed worker in qualitative analysis. In discussing the objections to the hydrogen sulfide method,

the author refers to the slowness of the precipitation and to the well-known instability of moist sulfides.

The division of the cations into groups is effected as follows: **I.** Hydrochloric acid—Ag, Hg_2, Pb; **II.** Sulfuric acid and alcohol—Pb, Ba, Sr, Ca; **III.** Potassium hydroxide and sodium peroxide—Sn, Al, Sb, Zn, Cr, As; **IV.** Solution of precipitate from last treatment by hydrochloric and nitric acids, neutralization with ammonium carbonate and addition of ammonium hydroxide and phosphate—Mn, Bi, Fe, Mg; **V.** Cu, Hg, Co, Ni, Cd in solution as complex ammonium salts. The alkalies are tested for either in the original solution or after the removal of Group **II.**

The grouping of the anions does not differ essentially from that of the conventional method.

One notices the mention of certain reagents not in general use, such as formin, *o*-hydroxyquinoline, indigo suspension, α-naphthylamine, pyridine-thiocyanate, sulfanilic acid, titan yellow, uranyl acetate and benzine.

The laws governing chemical changes are adequately discussed, but are not over emphasized, the point of view of the author being, apparently, that the major concern of the analytical chemist is the practical problem of analysis.

From an educational standpoint the book is stimulating because its departure from the accustomed procedure brings in the study of a rather unusual group of chemical reactions. This cannot fail to quicken the interest of the real analytical chemist. Whether the suggested system of analysis be adopted or not, it certainly merits serious consideration, and as the author suggests in his preface, it will hardly appeal to the "cook-book" chemist.

An obvious criticism is the fact that no scheme of analysis can be complete or of lasting value which does not include, at least, some of the so-called rarer elements which have in recent years become important constituents of many industrial products.

PHILIP E. BROWNING
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Organic Syntheses. Volume X. An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. HANS T. CLARKE, *Editor-in-Chief*, with ROGER ADAMS, JAMES B. CONANT, HENRY GILMAN, C. S. MARVEL, C. R. NOLLER, FRANK C. WHITMORE, and C. F. H. ALLEN, *Secretary to the Board, McGill University, Montreal.* John Wiley & Sons, Inc., New York City, 1930. vii + 119 pp. 15 × 23 cm. $1.75.

The volume contains the following list of thirty-one preparations, of which seven are by members of the editorial board:

Acetol, *n*-Amyl Benzene, Benzenesulfochloride, Benzophenoneoxime, Bromoacetone, α-Bromonaphthalene, Casein, *o*-Chlorobenzoic Acid, Dimethylglyoxime, Diphenylmethane Imine Hydrochloride, Durene, Duroquinone, Erucic Acid, Ethyl Fumarate, Ethyl Oxomalonate, Glutaric Acid, Heptanol-2, Lauryl Alcohol, Malononitrile, Methyl Oxalate, *m*-Nitroacetophenone, Oxalic Acid (Anhydrous), α-Phenyl-β-Benzoylpropionitrile, Piperonylic Acid, 1-Propylene Glycol, iso-Propyl Lactate, Pyromellitic Acid, β-Resorcylic Acid, Sodium 2-Bromoethanesulfonate, Taurine, *l*-Tryptophane.

In the appendix are later references to forty-four preparations which have appeared in preceding volumes, together with certain corrections. Each new volume is a very welcome and valuable addition to the chemist's book shelf. The present one maintains the high excellence of the series and is characterized by an increase in the number of preparations of biochemical nature; a fact to be commended since there is a need for such types of syntheses that are thus made readily available and are carefully standardized. Interesting features in this respect are the use of the pH values in the preparation of casein and the convenient biochemical method of asymmetric reduction used in the preparation of 1-Propylene Glycol.

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Colloid Symposium Annual. Volume VII. Edited by Dr. H. B. WEISER, Professor of Chemistry at the Rice Institute. John Wiley & Sons, Inc., New York, 1930. 23 × 15 cm. viii + 300 pp. 127 figures. $4.50.

This book, formerly called the "Colloid Symposium Monograph," contains all the papers presented at the Seventh Symposium on Colloid Chemistry, held at the Johns Hopkins University, June, 1929.

Titles of the papers and authors are as follows:

1. "The Scattering of Light in Sols and Gels." F. G. DONNAN and K. KRISHNAMURTI.
2. "The Structure of Gelatin Sols and Gels." S. E. SHEPPARD and J. G. MCNALLY.
3. "The Measurement of Hydration of Gelatin and Similar Materials and the Relation of Hydration to Swelling." HARVEY A. NEVILLE and EDWIN R. THEIS.
4. "The Influence of Adsorption on the Growth of Crystal Surfaces." KARL F. HERZFELD.
5. "Crystal Structure and Adsorption from Solution." WESLEY G. FRANCE.
6. "Significance of the Electrocapillary Curve." A. FRUMKIN.
7. "Determination of the Number of Free Electric Charges on Air Bubbles and Oil Droplets Dispersed in Water Containing a Small Amount of Cetyl Sulfonic Acid." JAMES W. MCBAIN and ROBERT C. WILLIAMS.
8. "The Electrostatics of Flotation." H. B. BULL.
9. "Some Evidence on the Nature of Extra-Molecular Forces." DONALD H. ANDREWS.
10. "The Adsorption of Vapors." WALTER A. PATRICK.
11. "The Specific Surface Area of Activated Carbon and Silica." F. E. BARTELL and YING FU.
12. "Compound Formation with a Volatile Base or Acid." WILDER D. BANCROFT, C. E. BARNETT, and B. C. BELDEN.
13. "Nature of Interaction between Hydrous Oxides and Mordant Dyes." OTTO REINMUTH and NEIL E. GORDON.
14. "The Apparent Specific Gravity and Moisture Content of Clay." FRANK K. CAMERON and RICHARD A. LINEBERRY.
15. "Progress in the Study of Clay Minerals." EDGAR T. WHERRY, CLARENCE S. ROSS, and PAUL F. KERR.
16. "The Colloidal Nature of Some Finely Divided Natural Phosphates." K. D. JACOB, W. L. HILL, and R. S. HOLMES.
17. "The Nature of Flow." EUGENE C. BINGHAM and BAXTER LOWE.
18. "The Adsorption of Fats from Volatile Solvents." HARRY N. HOLMES and CLIFFORD J. B. THOR.
19. "The Chemistry of Bacteria and the Development of a Practical Technic for the Chemical Analysis of Cells." TREAT B. JOHNSON.
20. "Human Blood Serum as a Colloidal System." S. DEW. LUDLUM, A. E. TAFT, and R. L. NUGENT.
21. "The Liesegang Phenomenon in Gall Stones." J. E. SWEET.
22. "Studies on the Porous Disc Method of Measuring Osmotic Pressure." J. C. W. FRAZER.
23. "Adsorption and the Permeability of Membranes." HARRY B. WEISER.

The established tradition of excellence and variety in the papers presented has been continued in this volume. One cannot read many of them without receiving inspiration for work in this important field. A detailed review of such a compilation is scarcely practicable. Inclusion of the discussion on each paper might be an improvement. However, the reviewer wishes to congratulate the publishers and the editor on their successful effort. Every colloid chemist will want to add this volume of the annual to his set.

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Diatomaceous Earth. ROBERT CALVERT, Chief Chemist, Van Schaack Bros. Chemical Works, Chicago (formerly in Charge of Research Laboratory, The Celite Company, Lompoc, California). American Chemical Society Monograph Series No. 52. The Chemical Catalog Company, Inc., New York City, 1930. xiii + 251 pp. 70 figs. 15 × 23 cm. $5.00.

This authoritative work on diatomaceous earth will be welcomed by all who have to do with this interesting and relatively abundant natural resource. Owners of diatomite deposits will be able to make some comparisons of their own material with that from other sources and to learn something of its uses and of the market conditions affecting its commercial exploitation. They will also discover that the successful development of their deposits and the marketing of the resulting products are dependent on the degree to which they are able to control these operations by thorough-going scientific research. Representatives of the various industries that involve filtration, heat insulation, concrete manufacture, and a wide variety of other activities will here find summarized with appropriate tables and graphs the results of much original experimental work dealing

with the adaptation of different grades and types of diatomaceous products to the requirements of their respective industries.

The first half of the work is concerned with the description of diatomaceous earth, its production, its mode and places of occurrence, its mining and preparation for the market, and its physical properties. The second half is devoted to the technology of the application of various types and grades of diatomaceous earth to the industries above enumerated. The former connection of the author with the world's largest producer of diatomaceous earth lends point to his discussion and indicates that his account may in considerable measure be considered as a record of the experience of this company in attempting to develop and market an exceptionally large and high-grade deposit.

A geological reader, such as the reviewer, would have liked to find a little more discussion of the geological setting of the various deposits mentioned, and he misses especially the maps and sections which would have elucidated that phase of the discussion much more satisfactorily than has been practicable in the present volume. On the other hand, the author, being a chemist, has been able to set forth much more fully and satisfactorily the technological conditions attending the commercial use of diatomaceous earth than would have been possible had he been a geologist. Possibly this is a case where coöperation between representatives of the two sciences would have produced a more rounded and more satisfactory treatise than could have been made by either chemist or geologist.

The book is attractively printed in compact form. It contains numerous well-selected halftone illustrations and is provided with indexes both of authors and of subjects. Many references are made to U. S. and foreign patents.

G. R. MANSFIELD
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BULLETINS

Galvanometers. Catalog No. 20. Leeds & Northrup Co., Philadelphia, Penna. 1930. 40 pp. Diagrams. 20 × 26.5 cm. Free.

This catalog contains descriptions of galvanometers which cover practically the entire range of applications for which they may be used.

CO_2 Meters (Electrical). Bulletin No. 781. No. 5—Power Plant Series, Leeds & Northrup Co., Philadelphia, Penna., 1929. 24 pp. Diagrams. 20 × 26.5 cm. Free.

Most Food Poisonings Caused by Meat. Meat and meat products are responsible for most food poisoning outbreaks, members of the American Public Health Association were told recently at their Minneapolis meeting, by Drs. Thomas G. Hull and Lloyd Arnold of the Illinois State Department of Health and the University of Illinois College of Medicine.

When much meat is eaten, the bacteria normally found in the small intestine, where meat is chiefly digested, are disturbed, the doctors explained. The germ-killing action normally occurring in the small intestine is interfered with for six hours after a meat meal. Thus when germs are taken into the system with a meat meal, they have a good chance to develop and cause illness.

Material containing a germ frequently implicated in food poisonings will produce irritations of stomach and intestines when it has been added to fresh meat, but no poisonous effect can be seen when the same material is added to a bread and milk diet, the scientists declared.—*Science Service*